ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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An open competitive examination of applicants for engineering positions in the department of the State Engineer and Surveyor, will be held at the Capitol, Albany, N. Y., on May 18. Assistant engineers must have had three years' practical field experience, one of which shall have been passed in responsible charge of work; salary, $5 to $6 per day. Levelers must have had two years' practical field experience; salary, $4.50 per day. For rodmen no actual experience is required, but proper weight will be given to experience in examination; salary, $3.50 per day. Applicants must be citizens and residents of the state of New York for the past year. For application blank and further information candidates should address Clarence B. Angle, Secretary, New York Civil Service Commission, Albany, N. Y.

Proposals for the four-track steel viaduct for the New York Central & Hudson River R. R., described in our issue of April 13 were opened May 4 by the Board for Park Ave. Improvement. The bids were as follows:

	Sec. 1.	Sec. 2.	Sec. 3.	Sec. 4.
Elmira Bridge Co..	$373,000	$344,000	$379,000	$424,000
King Bridge Co....	464,756	397,546	424,449	510,426
New Jersey Steel & Iron Co.....	357,000	311,300	333,000	.....

The Elmira Bridge Co. bid for any one section or the whole of the work, and it was understood that the King Bridge Co. did the same. The New Jersey Steel & Iron Co. bid for any one of the first three sections, but not for more than one; nor did it make a bid for the fourth section. The contract will probably be awarded this week. In our next issue we shall publish the plans for this work.

The three twin-screw steamships under construction by the Cramps, at Philadelphia, for the Inman Line will register 13,000 tons, or 500 tons more than the "Campania." The same Philadelphia item says they will be 18 ft. shorter on the water-line than the new Cunarder, but will be 60 ft. wide, or 3 ft. 9 ins. broader than that vessel. The engines are to develop 30,000 horse-power.

The use of the Wells light for night work, and for melting lead, and for melting out lead joints in cast iron pipe, is the subject of a short paper in the "Journal of the New England Water-Works Association" for March, 1893, by Mr. E. P. Gardner, Superintendent of the water-works of Norwich, Conn. Mr. Gardner states that he has used the light all night with the thermometer at 6°, and again at 75°, in still and windy, in clear and in very rainy weather. About one gallon of oil per hour is consumed per light. In melting out lead joints, Mr. Gardner states that the coating of the cast iron pipe is not destroyed as is the case when an ordinary fire is used.

The committee of the Brooklyn Bridge Trustees which has charge of the construction of the reconstruction of the New York terminal station opened bids for the work on May 4, as follows: Levering & Garrigues: $247,629 with a Crane elevator included; $251,304 with an Otis elevator included, and $240,629 with no elevator; work to be done in nine months. Phoenix Bridge Co.: $250,887, $252,857 with Crane elevator excluded, $263,552 with Otis elevator included; work to be done in eight months. Milliken Bros.: $265,642, $260,342 with Crane elevator excluded, $271,017 with Otis elevator included; work to be done in six months. Seaman & Son bid $165,000 for the carpenter and masonry work. The work was described in our issue of April 13. The contract has been awarded to Levering & Garrigues, at $240,629, and the contract for elevator will be let separately.

The use of unfiltered water in the buildings of the World's Columbian Exposition has been prohibited by order of Mr. John E. Owens, Medical Director. A printed notice posted throughout the grounds states that filters must be placed in all buildings. As has previously been stated in these columns, the Waukesha Hygeia Mineral Springs Co. proposes to have water on sale throughout the grounds, the price having been fixed by the authorities at one cent per glass.

The number of compound locomotives built in this country is given by the "Railway Master Mechanic" as about 500 up to April, 1893, as follows: The Baldwin Locomotive Works had built or in course of construction about 410 Vauclain four-cylinder compound locomotives; the Rhode Island Locomotive Works, 30 two-cylinder and 9 four-cylinder (Johnstone); the Schenectady Locomotive Works, about 40 two-cylinder; the Brooks Locomotive Works, 1 two-cylinder and 1 four-cylinder; Rogers Locomotive Works, 1 two-cylinder; Cooke Locomotive Works, 1 two-cylinder compound. About six two-cylinder engines have been built by railways.

A train of vestibuled saloon cars has been put on by the Prussian railway administration to run between Bremerhaven and Bremen and Berlin. The train consists of five first-class and five second-class cars, built on the American plan, and furnished in elaborate style. Each car contains a saloon compartment finished in wood, with silk hangings and upholstering; also a number of staterooms, with toilet arrangements, etc. A new express train has been put on between Bremen and Berlin, by which the number of daily express trains between these cities is increased to five.

Eight tank engines for switching purposes, with six wheels, all coupled, are being built by the Rogers Locomotive Works, Paterson, N. J., for the Chilean Government Railways. 5 ft. 6 ins. gage; cylinders, 13×22 ins.; driving wheels, 4 ft. diameter; boiler, 3 ft. 8 ins. diameter.

The most serious railway accident of the week, and the most serious which has occurred for some time, was the derailment of a passenger train on the Cleveland, Cincinnati, Chicago & St. Louis R. R., at Lafayette, Ind., May 7. The train came down the grade to the Wabash River bridge (about 0.5 to 1% grade) at high speed, and got beyond control. It is also stated, as usual in such cases, that the air brakes failed to act. In most of these, the failure of the brake is merely in the imagination of the newspaper reporters, and when the brakes do fail, it is generally for want of proper care and attention rather than any actual defect in the brakes. The engineman whistled for brakes on nearing the bridge, and then, it is reported, reversed his engine, but just after crossing the bridge the engine jumped the track at a curve, and ran into the station building. The baggage car, two mail cars and the express car were derailed and wrecked, and the first passenger car was damaged, but none of the passengers were killed. Ten persons were killed, four of whom had been waiting for the train at the station. About ten persons were injured.

A railway bridge over the Platte River at Grand Island, Neb., on the Burlington & Missouri River R. R., gave way May 2, just after a passenger train had passed. A trestle on the Kansas City, Springfield & Memphis R. R., at Mammoth Springs, Ark., gave way under a freight train May 1; five cars went down, and one man was killed. The bridge carrying the Central Vermont R. R. over Otter Creek, near Middlebury, Vt., gave way under a freight train, May 5, throwing nine cars into the creek. The engine passed over in safety. The bridge was of wood, 231 ft. long, built in 1890.

Numerous bridge washouts have occurred. The new iron bridge at New Boston, N. H., was carried away May 5. In Vermont, several bridges on the Central Vermont R. R. have been damaged, the railway trestle at Proctorsville washed out, and highway bridges carried away near Barre and Brattleboro. The temporary trestle carrying the Pittsburg, Cincinnati, Chicago & St. Louis Ry. over the Tuscarawas River, at Newcomerstown, O., washed away May 2. In Ohio bridges have been carried away at Miamitown, Springfield and Higby's. A wagon bridge at Alton, Ill., was washed out May 1, and the Chicago, Burlington & Quincy Ry. bridge damaged. A light bridge at the Carnegie blast furnace at Braddock, Pa., reaching from the ore car trestle to the furnace, gave way May 5, throwing several men to the ground; 14 men were injured, some seriously.

The dam of the Lewiston reservoir, near Huntsville, Logan County, O., gave way May 3, and the flood caused much damage. Several bridges were swept away.

A section of the main sewer under Harrison Ave., draining Lick Run, at Cincinnati, O., gave way May 1, and the street collapsed for a distance of about 60 ft.

The "Admiralty Special" train, conveying the American and foreign officers from the Chicago Exposition back to New York, made the following speed record over the New York Division of the Pennsylvania Railroad. From Philadelphia to Jersey City, 92 miles, in 1 h. 40 m.; an average of 55.2 miles per hour. Between New Brunswick and Elizabeth the 18 miles were covered in 14 m., at a speed of 78 miles per hour. The train was made up of four sleepers, two dining cars, a smoking and baggage car, and a buffet and observation car. These eight cars averaged in weight 90,000 lbs. each, or 720,000 lbs. for the train.

The high speed of a mile in 35 seconds, equivalent to the rate of 102 miles per hour, is said to have been attained by the Empire State Express of the New York Central & Hudson River R. R., between Rochester and Buffalo, May 9. The train made the run between Rochester and Buffalo, 69 miles, in 68 minutes, including a stop at Batavia. Between Lonevville and Grimesville, one mile was run in 42 seconds, and between Grimesville and the Forks, a mile was run in 35 seconds.

The first test of American made, rolled nickel-steel armor-plate, with curved surface, took place at Indian Head on May 1. The plate was made by the Carnegie Steel Company, was 8 ins. thick, and represented a lot of 250 tons of nickel-steel armor intended for the turrets of the "New York" and "Monterey." One Carpenter and two Holtzer projectiles were fired at the test plate from a 6-in. rifle, with velocities of 1,764, 1,800 and 1,978 ft.-sec., respectively. The first shot penetrated the plate and rebounded; the second stuck in the plate, and the third went through plate and backing. But none of the shots cracked the plate, excepting in the usual fringe around the holes. The test was considered by the government experts present as proving that rolled armor, bent in the process of manufacture, was equal in ballistic resistance to forged plates after they are bent to the same form. In other words, the bending operation does not tend to weaken the plate.

The extension of the Government gun plant at Watervliet is nearly completed in all its departments, and, meanwhile, much work is being done. As showing the magnitude of this plant, it may be said that a late list of the work in hand includes the following: Fifteen 12-in. guns under construction, with four nearly completed; twenty-three 10-in. guns, and eleven finished; twelve 8-in. guns are in advanced stages of progress, and ten 7-in. mortars are finished, and ten more mortars are under construction. Of field siege guns, ten 5-in. guns are finished, and ten more are under way; fifty 3.2-in. field pieces are in more or less advanced stages of construction, and twenty-four 3.6-in. field pieces and sixteen 3.6-in. mortars come under the same category.

The 4,000-ton lake steamer "S. S. Curry" was launched at Bay City, Mich., on April 20. This steamer, the largest on the lakes, is 378½ ft. long over all, 360 ft. on the keel, 45 ft. beam and 25 ft. deep. The engines are 23×37-in. and 63×44-in., and all the machinery is placed amidship instead of in the stern. The latter was the common practice on the lakes, but to this faulty arrangement was ascribed the late loss of the "Gilcher" and "Western Reserve."

The first compressed air plant in Germany was put in operation at Offenbach, September, 1891, supplying at the start 7 consumers, representing a total of 15.5 HP., says the "Zeitschrift fuer Transportwesen und Strassenbau." At the close of the first year, of this enterprise (September, 1892) 34 motors, aggregating 157 HP., were supplied with compressed air. Of this amount 35 HP. are used for the operation of the electric light plant of the town, so that 122 HP. are available for industrial purposes. The daily consumption at Offenbach amounts at present to 1,030,500 cu. ft. The pressure in the conduits ranges between 6 and 6.5 atmospheres.

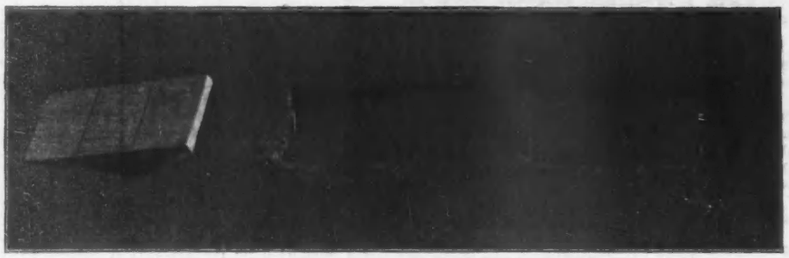
THE STABILITY OF FOUNDATIONS UNDER VARYING ANGLES OF LOAD-APPLICATION.

We are indebted to Prof. James L. Greenleaf, of Columbia College, for the following extremely clever method of demonstrating to his pupils the principle underlying the application of a load to foundations under varying angles of thrust. The effect of permitting the resultant to fall outside of the "middle third" is very clearly shown and in such manner that the dullest student cannot fail to remember this effect even if he fails to grasp the governing law. The following is the substance of Professor Greenleaf's letter:

It is a generally accepted opinion among engineers that some of the most difficult problems of the profession show themselves in the building of foundations. A truth less widely appreciated, because experience in that line is more limited, is that the laying of the foundation principles of the profession in the understanding of the student offers quite as intricate problems. The most stable rock and gravels, quicksands, and exceedingly soft strata, all have to be made to support the same superstructure, and they occupy adjoining chairs in the recitation room.

In teaching the laws of stability of masonry, I have found the mind of the novice especially inert to certain of them. His ordinary conception of things, trained by daily experience from boyhood up, leads him to readily appreciate, for example, that the line of pressures must fall within the base of support; but when one states the law and deduces the formula for variation of unit stress over a foundation bed, due to eccentric location of the resultant pressure, then the student draws in vain upon his store of practical experiences.

He can understand that it is necessary to keep the resultant pressure within the base, in order to prevent overturning; but, he says, so long as the resultant falls anywhere within the base, it is impossible for the structure to overturn. In short, the "middle-third theory" is liable to be a mere mathematical abstraction to the student, unless, as rarely happens, he has had some preparation for its reception by a previous drill in the elastic theory of beams and arches.



GRAPHIC REPRESENTATION OF THE "MIDDLE-THIRD" THEORY IN FOUNDATION LOADS.

In searching for a means of making the class in engineering at Columbia College feel the truth of the middle-third theory, and not give it a merely passive allegiance, as something that their mathematics forced upon them, I had resort to an experiment which is quite clearly shown in the accompanying illustration. The results were very satisfactory, conforming so closely to the dictates of the formula, that I believe they will be of interest to those older students of the profession, who, in the midst of active practice, are sometimes prone to forget that there are such things as formulas.

Moist molders' sand was used to give a compressible earth of homogeneous nature, and a block of wood 5 ins. by 2½ ins. by ⅝ in. thick served the part of the foundation bed of masonry wall. A force, representing the resultant pressure on the foundation of the wall was applied along a line across the block. For the impression on the right, the resultant passed through the center line of the block; for the next impression, it passed through the limit of the middle third, and for the one on the left it was located nine-sixteenths of an inch beyond the middle-third.

The impression on the right shows the uniform compression to be expected in that case. In the middle impression it will be seen that at the right hand end the unit pressure was zero. The compression completely fades out at that point, although a crack in the earth gives some appearance of shadow in the photograph. The dark shadow along the further edge, thinning out to a point, shows how precisely the experiment agrees with the theoretical discussion, which requires that the unit pressure shall diminish from a maximum at the left to zero at the right. The block has been left in the left hand impression in order to show how the application of pressure caused the right hand end to tilt in the air. This indicates a tension stress at that point, and is a result entirely in conformity with the formula.

It will surprise one on making this simple experiment to discover how sensitive it is; only a slight deviation from the middle third being required to cause the end of the block to rise in the air. He will also find another substantiation of the law on which the formula is based, which will, at first, trouble him in making the experiment.

A fundamental hypothesis is that the earth be homogeneous, and until care is taken to break up and pack the molders' sand uniformly before experimenting, it will be found impossible to obtain satisfactory results.

WORLD'S COLUMBIAN EXPOSITION.—X.

(With inset.)

Electricity Building.

The enormous development of electrical industries and the application of electricity during the last decade made it evident in the original preparations for the Exposition that considerable space must be provided for and attention paid to the electrical department. A special Department of Electricity was organized, and one of the main buildings devoted entirely to this department. The Electricity Building is one of the group of main buildings fronting on the central square, and its location is indicated on the maps in our issues of Jan. 16 and Oct. 13, 1892, while its general appearance and style were illustrated and described in our issue of Feb. 13, 1892. It is side by side with the Mines and Mining Building, described and illustrated in our issue of May 5, 1892, and opposite the Machinery Building, described and illustrated in our issues of June 30 and July 7, 1892. Mr. J. P. Barrett is Chief of the Department of Electricity. Mr. Frederick H. Sargent was Electrical and Mechanical Engineer until March, 1893, when he resigned, and his principal assistants appointed to succeed him, Mr. R. H. Pierce as Electrical Engineer, and Mr. C. H. Foster as Mechanical Engineer. The electric lighting arrangements for the Exposition were described in our issue of April 27, and the main buildings have been described and illustrated in detail in previous issues as follows: Horticultural Building, March 12, 1892; Mines and Mining Building, May 5, 1892; Machinery Building, June 30 and July 7, 1892; Manufactures Building, July 28, Sept. 1 and Sept. 8, 1892; Transportation Building, Dec. 29, 1892. Besides these we have published descriptions of the buildings and other features of the Exposition in numerous issues.

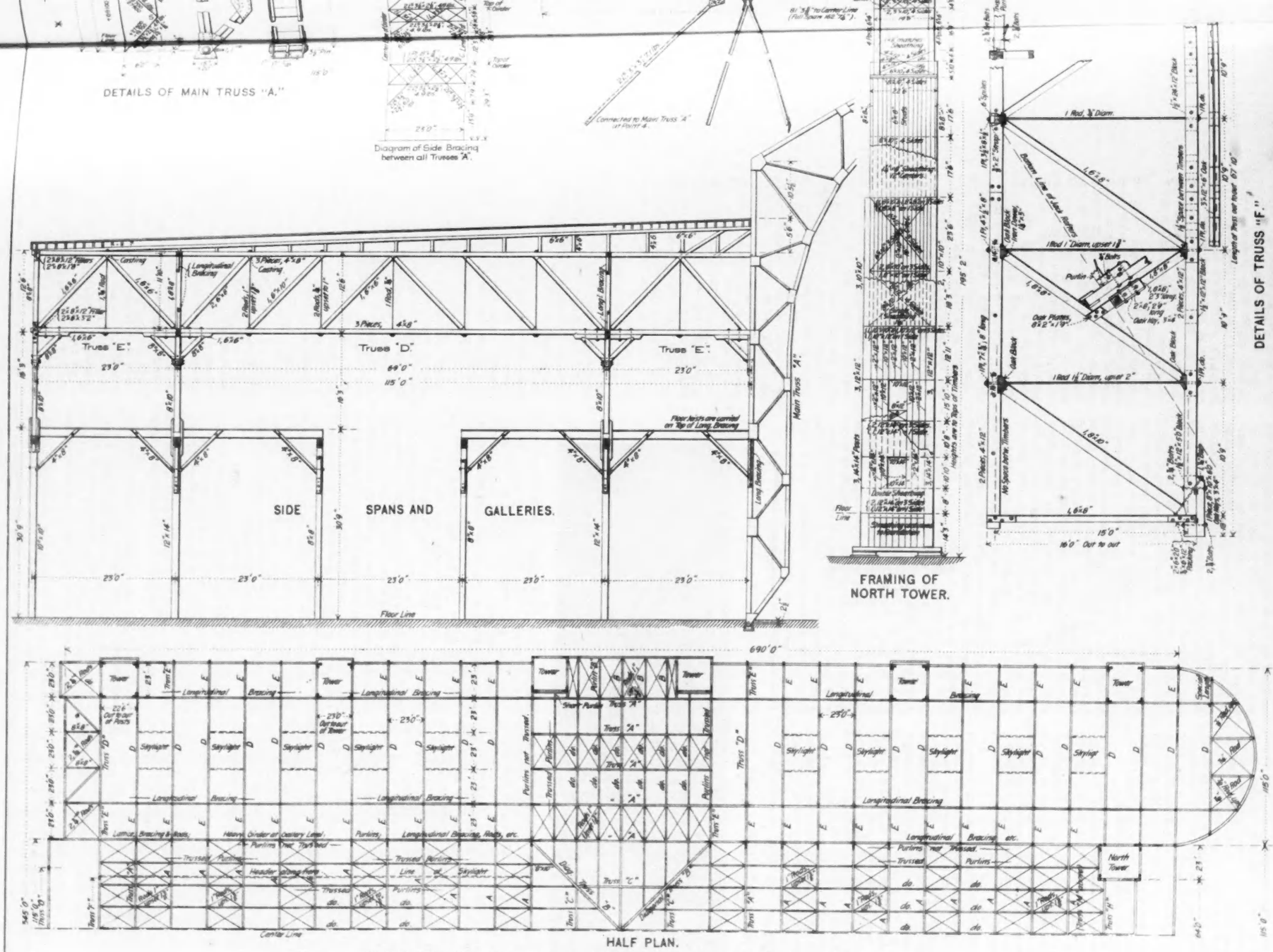
The Electricity Building is rectangular in plan, 700 ft. long (north and south) and 345 ft. wide, with two semi-circular bays on the north front. There are a nave and transept, of steel construction, each 115 ft. wide and 114 ft. high, the remainder of the building being of timber construction, with flat roofs supported by combination trusses, as shown by the cross section on our inset sheet. Galleries are built all round the building, 115 ft. wide and 30 ft. above the main floor. These galleries are the full width of the timber construction, but open spaces are provided at intervals to secure light and ventilation for the floor below. The building covers about 5½ acres and the estimated cost was $375,000. The architects were Van Brunt & Howe, of Kansas City, Mo., but the main structural ironwork and all the details of construction were designed by the engineers of the Bureau of Construction, under Mr. D. H. Burnham, Director of Works. Mr. E. C. Shankland, Chief Engineer, designed the structural ironwork of all the main buildings, which has been a work of no small importance, and these buildings, from their design and construction, as well as their magnitude, are in themselves highly interesting exhibits to engineers and ironwork manufacturers, as has been shown by our descriptions and illustrations of the buildings.

The pitched roofs over the main trusses have a clearstory or ventilator roof at the ridge, and have skylights at the foot of the pitch. There are also skylights in the flat roofs. The height of the main walls is 68 ft. 6 ins., corresponding to that of the other main buildings, but the pavilions at the principal entrances rise above this, and there are towers 168 ft. high, while the two towers flanking the north entrance pavilion are nearly 200 ft. high. The south pavilion, fronting on the central square, and forming the main entrance, has a deeply recessed semi-circular vestibule, 78 ft. diameter and 103 ft. high. There are also entrances provided along the sides, including an entrance pavilion at the middle of each side. Special arrangements have been made for electric illumination of the exterior by night. The ground floor has an area of about 5 acres, and the galleries have about 2½ acres of floor space. In the building there are 176 closets for men and 108 for women, 52 and 56 closets being free and the others available at a fee of 5 cts., and there are also 42 lavatories for men and 56 for women, for which the same fee is charged. There are offices and free and pay toilet rooms on the main and gallery floors, and in each of the large bays on the north front will be (on the gallery floor) a restaurant, with dining rooms along the outside separated from the restaurant by a corridor. The main floor is 12 ft. above the water level of the lake and lagoon, and is designed for a load of 150 lbs. per sq. ft., special foundations being provided under heavy exhibits. The design of foundations and floors has been described and illustrated in our issues of March 5, July 7 and Dec. 29, 1892.

The main trusses, "A," of the nave and transept rise from the floor level, and have a span of 115 ft. c. to c. of the shoe pins, which pins are connected by tie-rods beneath the floor. These trusses are built up of steel angles and lattice bars, with riveted connections, and having 3½-in. pins at the shoes, and 3-in. pins at the apex of the top chord. The outer chords are vertical to a length of 75 ft. 8 ins., and then inclined to a height of 114 ft. above the floor. The inner chords are vertical to a height of about 40 ft., and are then arched with a radius of 51 ft. 6 ins. The width of the legs of the truss is 6 ft. and the depth at the middle is 16 ft. The diagonal trusses, "B," which connect the main trusses at the intersection of the nave and transept, have pin connections. Trusses "C" connect the tops of the diagonal trusses. The main trusses are 23 ft. apart, c. to c., and are connected by two rows of longitudinal lattice girders, with stay angles to the trusses, as shown. Above the upper longitudinal girder the trusses are connected by ¾-in. diagonal rods. The roof is supported by nine rows of purlins. The purlins of seven of these rows are trussed, and the others, which are at the foot of the pitch, are not trussed. The trussed purlins are 22 ft. 2 ins., 23 ft. 10 ins. and 27 ft. 5 ins. long. The main purlins are of two pieces, 4 × 10 ins., with a truss rod of 1 3-16 in. diameter upset to 1½ in. The truss depth is 3 ft. 9 ins. The general specifications for material were published in our issue of March 26, 1892.

The timber construction outside of the steel trusses is divided transversely into five bays by columns spaced 23 ft. c. to c. both transversely and longitudinally. The inner and outer bays are spanned by trusses of 23 ft. span, while the three middle bays are spanned by combination trusses of 69 ft. span, all three of the trusses being 12 ft. deep, as shown by the cross-section on our inset sheet. The lower columns supporting the gallery floor are 12 × 14 ins., and the upper columns supporting the roof trusses are 8 × 10 ins. Longitudinal bracing is placed over the columns between the trusses, and the trusses, corresponding to the main trusses, are 23 ft. c. to c. At the ends of the building, and supporting the upper part of the pavilions, are heavy timber trusses, "M," of 37 ft. and 41 ft. span. The roof boarding is carried by joists 2 × 12 ins., spaced 16 ins. c. to c., and supported by rafters built up of two timbers 5 × 14 ins. and 3 × 14 ins.; these rafters being supported by posts resting on the trusses, as shown.

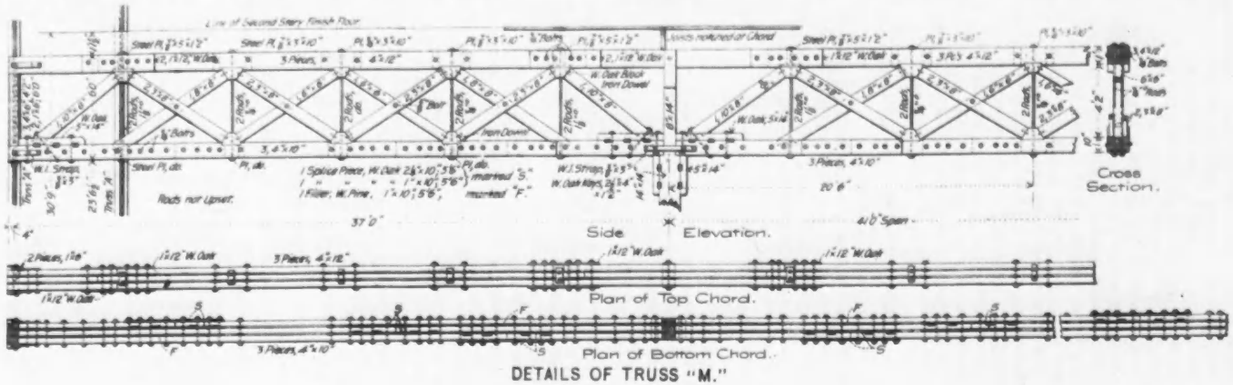
The towers, ranging in height from 160 to 200 ft., are of timber framing, the typical design being the same in all as in that of the two highest towers.



ELECTRICITY BUILDING; WORLD'S COLUMBIAN EXPOSITION.

Van Brunt & Howe, Architects. D. H. Burnham, Director of Works. E. C. Shankland, Chief Engineer.

CHAS. HART & SONS, LITH, 88 VESEY ST., N. Y.

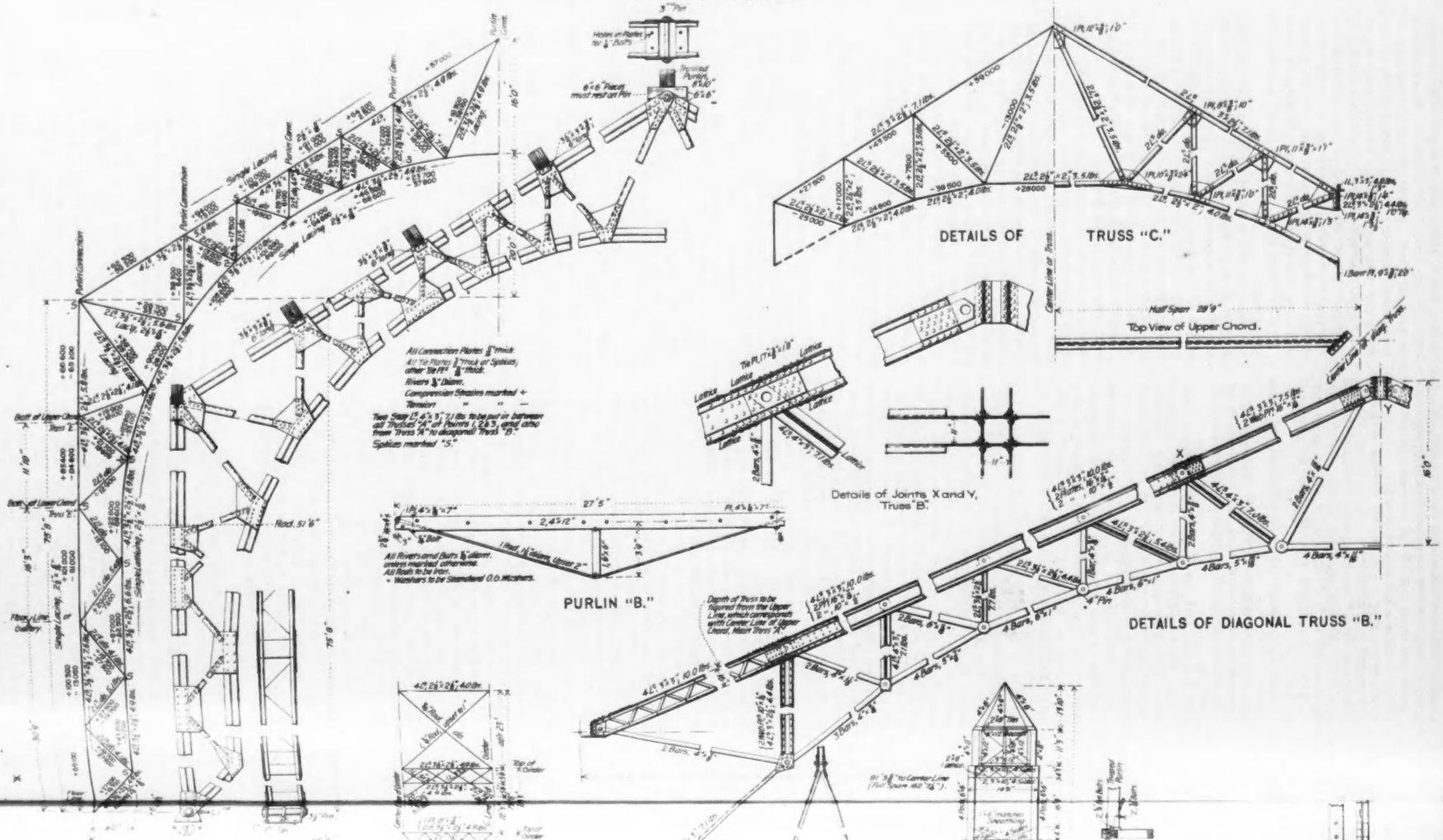


DETAILS OF TRUSS "M."

DETAILS OF TRUSS "C."

Details of Joints X and Y, Truss "B."

PURLIN "B."



DETAILS OF DIAGONAL TRUSS "B."

on the north front, illustrated on our inset sheet. The framing is of heavy vertical posts and horizontal timbers, with diagonal bracing; the sides filled in with studding and covered with 1¼-in. sheathing, to which the staff covering is attached. The exterior walls of the building are of frame construction, with staff covering and decorative work.

The interior is treated in blue, the coloring material being kalsomine, applied by the compressed air method described and illustrated in our issue of Feb. 23. The Exposition management will put in 450 arc lamps of 2,000 c. p., but the greater part of the lighting will be by the numerous lamps of various exhibitors. The decorative effects are of an appropriate character, including figures representing electricity, the telephone, the telegraph, the arc light, the dynamo, etc.

Electrical Exhibits.

The exhibits in this department will undoubtedly be very instructive and of general interest, showing the importance of the application of electricity to engineering and to general purposes. Mr. J. P. Barrett is Chief of the Department of Electricity.

The general rules issued by the Department of Electricity provide that all exhibits of electrical apparatus will be installed in the Electricity Building, excepting generators, and the adjuncts of a generating plant, which are intended to be shown in operation, and excepting also such apparatus and appliances as may be offered as exhibits for the service of the Exposition. Electric power only will be furnished in the building, and generators designed to be operated by steam power are located at some other point. Subways connect the building with the power station (Eng. News, Oct. 31, 1891; July 21, 1892; and April 27, 1893), and through these subways all wiring is done. The power station contains the plant under contract to serve the Exposition, and the generators of those exhibitors who exhibit generating plants of sufficient capacity only to operate the balance of their exhibits in the Electricity Building, and steam power for the running of these generators is furnished by the Exposition at a fixed price. The electric power plant was described in our issue of March 5, 1892. Appliances and apparatus such as electric elevators, search lights, etc., intended for exhibition, but offered and accepted for the service of the Exposition, have been installed wherever their service is required.

Ample facilities were furnished in the Electricity Building for moving articles or pieces of machinery weighing not over 30,000 lbs., by means of railway derricks, the terminal charge of 8 cts. per 100 lbs. covering the cost of moving articles of that size to their allotted space. Articles weighing more than 30,000 lbs. were subject to an extra charge covering the actual additional cost of handling. Tracks were provided so that freight could be hauled into the building, and generating machinery or parts of same to be installed for operation under load, weighing not over 45,000 lbs., were carried from the car to their proper location by means of traveling cranes. The expense of transporting, receiving, unpacking and arranging exhibits, as well as their removal at the close of the Exposition, devolves upon the exhibitor.

The Department of Electricity is designated as Department J, Electricity and Electrical Appliances, in the official system of classification, and comprises 17 groups (Groups 122 to 138, inclusive) and 63 classes (Classes 757 to 819). The following is an abstract of the classification of exhibits:

Group 122.—Apparatus Illustrating the Phenomena and Laws of Electricity and Magnetism.—Statical electricity; thermo-electricity; thermo-electric batteries; magnets, temporary and permanent; induction coils, converters.

Group 123.—Apparatus for Electrical Measurements.—Standard resistance coils, condensers and batteries; instruments of precision; voltmeters, ammeters, wattmeters.

Group 124.—Electric Batteries, Primary and Secondary.

Group 125.—Machines and Appliances for Producing Electrical Currents by Mechanical Power; Dynamical Electricity.—Dynamos of direct current, with constant E.M.F. and varying quantity, and of constant quantity and varying E.M.F.; dynamos of alternating current, with constant E.M.F. and varying quantity, and with constant quantity and varying E.M.F.

Group 126.—Transmission and Regulation of the Electrical Current.—Cables, wires and insulation; rheostats, switches, indicators, registering meters; ammeters, voltmeters; safety and protective appliances; lightning rods, lighting arresters, insulators, fusible cut-outs, safety switches; conduits, interior and underground.

Group 127.—Electric Motors.—Direct constant current; direct constant E.M.F.; alternating current.

Group 128.—Application of Electric Motors.—Street, underground, mining and other railways; elevators, pumps, printing presses and general machinery; toys, novelties and domestic appliances.

Group 129.—Lighting by Electricity.—The arc and incandescent systems, their lamps, fixtures and appliances.

Group 130.—Heating by Electricity.—For warming and heating apartments; for heating flat-irons, soldering irons and other objects used in industrial operations; maintenance of constant high temperature in ovens; electric heating furnaces.

Group 131.—Electro-Metallurgy and Electro-Chemistry.—Electrotyping, electroplating, gilding and nickeling; electro-deposition of iron and other metals; electrolytic separation of metals from their ores or alloys.

Group 132.—Electric Forging, Welding, Stamping, Tempering and Brazing.—Apparatus for and methods of forging, welding or joining iron, steel and other metals; brazing, stamping, tempering, etc.

Group 133.—Electric Telegraph and Electric Signals.—Various systems of transmitting and receiving; chronographs; annunciators; thermostats; fire alarm apparatus; police telegraph and burglar alarm apparatus; railway signal apparatus.

Group 134.—The Telephone and Its Appliances; Phonographs.—Cables; construction and underground work; special protective devices; switchboards; transmitting and receiving apparatus; signaling apparatus; long distance systems; various systems of operation; subscriber's apparatus; numbers, code, registers, etc.; phonographs, receiving and recording apparatus; apparatus for the reproduction of recorded sounds and articulate speech.

Group 135.—Electricity in Surgery, Dentistry and Therapeutics.—Cautery apparatus; apparatus for the application of the electrical current as a remedial agent, surgical and dental; apparatus for diagnosis, and for the destruction of life.

Group 136.—Application of Electricity in Various Ways not Hereinbefore Specified.—Ignition of explosives, gaslighting; control of heating apparatus by electricity, as applied to steam and hot air pipes and registers; electric pens; application in photography.

Group 137.—History and Statistics of Electrical Invention.—Objects illustrating the development of the knowledge of electricity and of the application of electricity in the arts; collections of books and publications upon electricity and its applications.

Group 138.—Progress and Development in Electrical Science and Construction, as Illustrated by Models and Drawings of Various Countries.—United States Patent Office and other exhibits of electrical models and drawings; foreign exhibits of electrical models and drawings.

Entrance Gates.

The gates of the Exposition were opened at 6a. m., May 1, and will not be closed until after the Exposition is at an end. Visitors, however, will not be allowed to enter after 10 p. m. The entrances at the stations of the intramural railway are divided into three sections, each in charge of a section inspector. The men stationed at the gates at these entrances will serve in reliefs of 3½ hours each. Under the section inspector will be squad inspectors, who will have charge of the subdivisions of the sections. From 6 to 8 a. m. special gates will be open for workmen at the grounds at five conveniently located points. These workmen, probably numbering 10,000 during the months of May and June, will not use the photographic pass, but will be provided with a card pass, void after 8:30 a. m. in the morning.

At the terminal railway station the gate-keepers will be transferred from one section to another as the trains arrive, and the same system will probably be carried out at the Casino pier. The number of gates available will vary at the entrances during the different hours of the day. The greatest rush is expected during the hours of 8 to 11:30 a. m. and 3 to 6:30 p. m., and in that time the number of gates will be larger than during the rest of the day.

Special gates have been provided for persons who hold free admission tickets. Altogether there are 20 entrances with a maximum total of 35 free and 108 pay gates. There are 66 exit gates, to be open from 8 a. m. until 10 p. m., distributed in proportion to the other gates. The entire number of gates has been based on the number that has already been required to receive workmen and visitors at Jackson Park. The entrances marked with an asterisk will have two additional gates from 3 to 6:30 p. m.. The following is the present arrangement of entrances, as approved by the Department of Admissions, but the Department states that it is subject to change.

Section 1.	No. gates from 8 to 11:30 and 3 to 6 p. m. Free.	Pay.	No gates from 11:30 to 3 and 6:30 to 10 p. m. Free.	Pay.
Cornell Ave.	1	2	1	2
Fifty-seventh St.*	2	8	1	4
Fifty-ninth St.*	1	8	1	1
Sixtieth St.*	1	6	1	3
West Plaisance	2	3	1	2
North Plaisance (two entrances, one on Woodlawn Ave. and one on Madison Ave)	1	2	1	1
South Plaisance (two entrances, same)	1	2	1	1
Rosalie court	1	3	1	2
Total.	10	34	8	16
Section 2.				
Chicago & S. S. Elev. Ry.*	1	5	1	4
Intramural Railway	1	1	1	1
Sixty-fourth St.	1	4	1	2
Sixty-fifth St.	1	1	1	1
Sixty-seventh St.	1	1	1	1
Terminal*	7	28	7	28
Total.	12	40	12	37
Section 3.				
Casino pier	6	18	6	18
Southeast end gate, at Palmer Ave. and Sixty-seventh St.	1	1	1	1
North pier	1	2	1	2
Total.	8	21	8	21
Total for all sections.	30	95	28	74

Architectural Congress.

The arrangements made for a series of congresses to be held under the management of the World's Congress Auxiliary in connection with the Exposition were described in our issue of April 20. One of these congresses will be the Architectural Congress, held during the week commencing July 31, at the same time as the Engineering Congress. The committee for the Architectural Congress consists of Daniel H. Burnham, Chairman; William Le Baron Jenney, Vice-Chairman; and Solon S. Beman. This committee has elected Robert C. McLeon as its secretary.

The following list of subjects has been recommended for consideration: Workingmen's houses; modern apartment houses; ancient apartment houses; laundries in houses, health effect; kitchens in houses, health effect; modern stables, large and small; responsibility of architects in constructional matters; responsibility of architects as to plans; responsibility of architects in decorative matters; sculpture and architecture; painting and architecture; the client's right to service, as to drawings, ownership of same, specifications and details, as to supervision, etc.; mechanical engineering in architecture, and the architect's responsibility therefor; modern steel construction; fire-proofing of buildings to date, etc. Persons specially fitted to treat upon these subjects have been invited to prepare papers to be read at the congress.

First Glimpses of the Exposition.

(Editorial Correspondence.)

A cluster of great white palaces surrounded by green lawns, broad terraces and rippling water; surpassingly beautiful decorations on every hand; gay flags and fluttering banners and broad masses of color; an indescribable air of holiday gladness over all; such are my first impressions of the World's Columbian Exposition. It is true that the legend "Unfinished" is written everywhere, from the roadways, where a host of men and teams are busily at work spreading and packing broken stone, to the exhibits in the buildings, where machinists, painters, carpenters, decorators, and workmen of every sort are busy as bees bringing order out of chaos. But despite all the plain evidences everywhere that the greatest show on earth is not quite ready for the performance to begin, there is enough, and far more than enough, to please and bewilder the visitor. The conviction is gradually dawning on me that nobody is going to see the whole of this vast exhibition, not through he labor from dawn till dusk at the task until its gates close at the end of October. Of course, one can set his foot in every building; and if he be a good walker or if he can spare sufficient cash to enjoy the luxury of a rolling chair, he can pass through the unnumbered miles of aisles in all the different buildings in the course of weeks. But, as to seeing everything and making a study of everything worth seeing one might as well try to com-

press a lifetime of liberal education inside of six months. However, as no one person is likely to want to study all the various departments this does not matter much.

There is no doubt of one thing—the Exposition is preeminently the triumph of the artist. His work is everywhere. The grounds, the fountains, the statues, the buildings, and the pavilions and exhibits inside, all are designed to please and attract the artistic eye. Verily what a gulf have we passed over since the Philadelphia Centennial.

The man whose exhibit is not up to the mark in good taste will feel this summer like a boy with patched trousers. His goods may be highly meritorious, but they will not appear so to a crowd educated by the display of countless artistic wonders on every hand.

There is one great building on the grounds, however, where the comparative simplicity and absence of bewildering decorative effects gives one a certain sense of relief. That is the Machinery Building. With its overhead traveling cranes and its array of engines and machine tools it bears some faint resemblance to a very huge machine shop into which all the modern improvements have been introduced.

I have said that the Exposition is unfinished; apparently it will be June before the final touches are put on. The foreign nations are very far ahead of the Americans. Their exhibits (and they are almost uniformly of great excellence) are already the centers of admiring crowds, while some of their American neighbors are only opening their packing cases. The exhibits in the Machinery Building, Transportation Building and Horticulture Building are farthest advanced, but in some of the others, especially the Electricity Building, hardly a fair start has been made toward placing the exhibits in position. However, with perhaps this exception the exhibits which are in position are so many and of such interest that one does not much miss the belated ones.

Chicago has made ample preparations for her visitors. The whole city, especially that part of it from which the Exposition grounds can be easily reached, has turned itself into a vast hotel. Every landlady and every owner of an apartment house has raised rates to the standard $1 to $3 per day for rooms, a price which the transient visitor can stand, but which sinks into despair the Chicagoan dweller in a boarding house or renter of apartments.

In fact, almost the only discreditable thing which I have seen around the whole city of Chicago in connection with its preparations for its visitors are the cattle cars in which the Illinois Central R. R. carries passengers between the business center and Jackson Park. These cars have been illustrated in Engineering News; and they ride as if every wheel had seven three-inch flat spots on it. The very cheap and nasty car body might have been excused; but to carry the car body on freight trucks which are not as good as those under a modern first-class stock car is wholly inexcusable. The trucks are said to be the company's standard freight trucks.

However, there are plenty of other ways of getting from the center of the city to Jackson Park which are more comfortable if not so fast or convenient; and in the long run the Illinois Central R. R. will doubtless be the chief loser from its spasm of parsimony. As a whole, the arrangements made for the comfort of the throngs of visitors, both by the residents of Chicago and by the managers of the Exposition, are astonishingly complete. In this respect, as in every other, 1893 will show a vast improvement over 1876.

TESTS OF NON-CONDUCTING COVERINGS FOR STEAM PIPES.

By R. C. Carpenter, M. Am. Soc. M. E., Professor of Experimental Engineering, Sibley College, Cornell University.

The convenience of having all the boilers of a steam plant at one point has frequently led to the adoption of methods of conveying steam long distances, either for power or heating purposes. For heating plants, this method will usually come in competition with the ordinary methods, where heat is applied in each building; and it is desirable to know whether the inevitable losses which occur in the line conveying the heat do not overbalance the saving due to the greater economy which can always be secured by the large steam plant.

When power is needed in various places at some distance apart, several methods present themselves. (1) One large plant from which mechanical power is obtained, and transmitted by long lines of shafting, or ropes or belts. (2) One large power plant from which power is obtained, and transformed into electrical energy, in which condition it is transmitted to electric motors, which perform the work. (3) Separate and complete steam plants located where the work is to be done. (4) One large boiler plant with separate engines, steam being transmitted in pipe lines to the various engines, located where the power is needed.

In the first system the losses are due principally to friction. This is usually nearly a constant loss, independent of the total power transmitted, and is frequently an excessive amount. In a recent test of a large cotton mill made by the writer the power absorbed by the friction of the main and countershaft was over 330 HP. The total power of the engine used to drive the mill was 1,050 HP. In this case over 30% of the full power was lost in transmission, and it is not an unusual or extreme case of this character.

With electrical transmission there is, first, a loss in transforming mechanical into electrical energy, and, second, a loss in re-transforming electrical into mechanical energy.

The use of separate and complete plants is the alternative for all these systems, and of course signifies the production of power, if we may use that expression, at the point where the work is to be done. It is open to the objections which attend the use of numerous boiler plants, and the want of economy characteristic of small plants. It means larger operating expenses and greater wastes; consequently this system of power distribution is not often employed unless the distances are very great.

The distribution of steam from a central boiler plant to separate engines is often practiced, and the amount and character of the losses which occur will no doubt be of general interest. The discussion of such losses as occur in the transmission of steam, either for heating or power purposes, is the principal subject of this paper.

Loss in the Transmission of Steam for Heating.—Heat for the buildings of Cornell University is obtained from a boiler plant at Sibley College, on the north side of the campus, and is transmitted by pipe lines laid underground to the various buildings constituting the University.

The pipe is laid in nearly a direct line to the various buildings, and is protected from heat losses by a wooden pipe; the pipe being made of a solid log, from which the central portion has been removed by a cylindrical saw. The bore of the wooden pipe is 2 ins. greater than that of the iron pipe which is inclosed, and the thickness of the wood wall composing the pipe is 4 ins., thus making the outside diameter of the wood pipe nearly 10 ins. greater than that of the inclosed iron pipe. The outside of the wood pipe is turned, protected by a spiral winding of hoop iron, and coated on the outside with hot coal tar and sawdust. It is seen that it insures for the steam pipe an air space of nearly 1 in. and 4 ins. in thickness of wood covering (Fig. 1).

The expansion of the line is provided for by variators made by the Holly Mfg. Co., of Lockport,

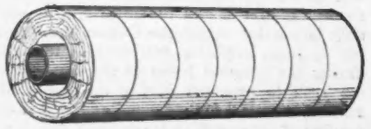


Fig. 1. Steam Pipe Covering on Underground Mains at Cornell University.

N. Y., which are located 50 ft. apart. The line consists of 150 ft. of 10-in. steam pipe, and 2,050 ft. of 6-in. pipe, making a total heating surface of 5,005 sq. ft. The pipe line was laid in 1889, and a test was made by Mr. Churchill within a few months of its completion.

For ascertaining the heat losses Mr. Churchill employed several methods. In one method sections of the line were taken, and calorimeter observations were made on the steam as it entered and left the line. The result of this investigation indicated a loss of heat in a distance of 2,025 ft. of nearly 10% of the heat transmitted. The other method of determining the loss was to ascertain the amount of heat required to keep the line heated to its working condition, this being done by closing off all the buildings, and making certain that there were no leaks existing in the line. The heat required was determined by a boiler test.

Mr. Churchill considered this the more satisfactory method, although the results did not differ essentially from those obtained by the first method. Three trials were made, the results being as follows:

Trial, No	Difference of temperature.	Loss in British thermal units. Total per hour	Per degree difference of temp.	Per sq. ft. of Surface
1.....	241°	1,021,370	4.237	.555
2.....	235°	811,047	3.452	.634
3.....	236°	932,110	3.991	.712

The first trial was made when the ground was very wet, and some soil water reached the pipe. The third trial was made under unfavorable circumstances. For these reasons the second trial is considered as giving results which represent the pipe line under best conditions.

The loss per square foot for a naked pipe, under the same conditions, would have been 570 B. T. U.,

SUMMARY OF TESTS OF LOSS OF HEAT, LEHIGH COAL STORAGE PLANT, SOUTH PLAINFIELD, N. J.

No.	Gauge Pressure. Boiler.	Gauge Pressure. Engine D.	Temperature. (a) (b) Boiler house.	Engine house.	Outside air.	Calorimeter entering steam.	Calorimeter steam at engine.	Moisture in Steam. Entering steam.	At engine.	Increase.	Total weight of steam in line.	Remarks.
	lbs.	lbs.	F°	F°	F°	F°	F°	Per ct.	Per ct.	Per ct.	p h. lbs.	
1	92	87	38	36	19	275	228	1.0	3.2	2.2	1700	
2	101	96	...	37	19	....	213	1.0	3.9	2.9	1300	
3	108	105	...	39	19	....	213	1.0	3.8	2.8	1305	
4	89	86	38	38	19	284	217	0.5	3.7	3.2	1190	
5	86	82	38	38	19	280	214	0.65	3.8	3.15	1080	
6	83	77	38	38	19	280	220	0.6	3.4	2.8	1700	
7	85	80	38	38	18	283	214	0.49	3.75	3.26	1100	
8	80	74	38	38	18	281	247	0.45	1.9	1.45	2500	
9	73	67	44	40	18	272	243	0.75	1.7	0.95	3600	
10	68	54	42	40	18	264	239	1.03	1.75	0.72	3600	
11	64	58	46	41	18	266	229	0.75	2.25	1.50	2510	
12	70	63	38	41	18	267	216	0.9	3.2	2.03	1600	
13	73	68	38	41	16	270	213	0.85	3.5	2.15	1500	
14	71	65	38	41	16	268	225	0.85	3.0	2.15	1800	
15	73	68	38	41	16	264	213	1.2	3.5	2.3	1800	
16	78	73	38	42	16	275	214	0.7	3.5	2.8	1500	
17	98	91	38	42	15.5	282	212	0.75	3.8	3.05	1300	
18	103	97	38	46	15	284	220	0.8	3.9	3.01	1200	
19	88	86	38	47	15	282	251	0.6	1.95	1.35	3300	
20	59	58	42	47	15	282	250	0.0	1.5	1.5	3000	
21	58	52	42	47	15	282	230	0.45	1.5	1.5	3650	
22	58	52	46	47	15	267	214	0.55	2.8	2.25	1800	
23	56	48	50	48	15	267	222	0.5	2.3	1.8	3200	
24	61	55	50	48	15	267	212	0.75	3.0	2.25	1800	
25	68	62	50	48	15	266	212	0.6	3.0	2.4	1500	
26	68	60	50	48	15	266	214	0.9	3.2	2.3	1500	
27	72	68	50	48	15	270	213	0.8	3.2	2.4	1600	
28	73	67	50	48	18	270	228	0.8	2.6	1.8	1800	
29	70	73	50	48	18	276	228	0.6	2.5	1.85	1800	Engines D, E, F, also run lights. Engine run lights. Engine run 2½ hours after lights. Engine run 2½ hours after lights. Eng. also light cars. D light.

Average amount of water caught in drips, 45.1 pounds per hour.
Average amount of water indicated by calorimeter, 36 pounds per hour.

which is equivalent to 2 B. T. U. for each degree difference of temperature. That is, the heat loss in the plant tested is 30.7% of that in the naked steam pipe.

Loss in Transmission of Steam for Power.—The surplus coal of the Lehigh Valley R. R., destined for the New York market, is unloaded at South Plainfield, N. J., by the Dodge system of coal handling machinery, stored in enormous conical piles, and then reloaded, as the state of the market demands.

The coal is distributed on either side of the track for a distance of 1,500 ft. The unloading and reloading machinery is heavy, and requires in each case large power which is only in occasional use, so that the problem in this case is, most efficient distribution of power to the various coal handling plants. The system adopted was that of independent engines of 75 to 150 HP. provided with steam from a central boiler plant.

The engines are in each case simple automatic engines, made by the Buckeye Engine Co. They are operated only when the machinery to which they are connected is required.

The total length from the boiler-house to the engine tested was 747 ft., consisting of 250 ft. of 6-in., 106 ft. of 5-in., and 391 ft. of 4-in. pipe, making a total radiating surface of 1,057.5 sq. ft.

The engine was 12×16 ins., running with a piston speed of 600 ft. per minute, thus requiring, when cutting off at one-third stroke, a velocity of the steam of about 60 ft. per second in the 391 ft. of 4-in. pipe next the engine. The reduction in pressure varied from 5 to 7 lbs., averaging 6 lbs.

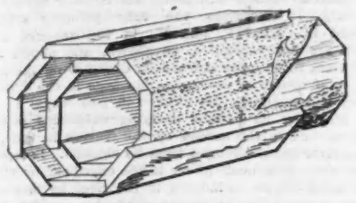


Fig. 2. Wyckoff Steam Pipe Covering on Steam Mains at South Plainfield, N. J.; Section Showing Water-Proof Paper Between Inner and Outer Shells.

The general method of testing adopted was such as to give information, (1), as to the amount of water in the steam as it entered the steam pipe; (2), the amount of water in the steam as it reached the engine; (3), the amount of water collected at intervening drips; (4), the total amount of steam used; (5), the fall in pressure between the boilers and the engine. These determinations were made as follows: The amount of water in the steam was determined by a throttling calorimeter, the sample of steam being drawn, in each case, from a vertical pipe located close to a bend from a horizontal, and collected by a ½-in. nipple extending past the center of the vertical pipe. The drip was caught at places which had been provided in the pipe, and was weighed from time to time.

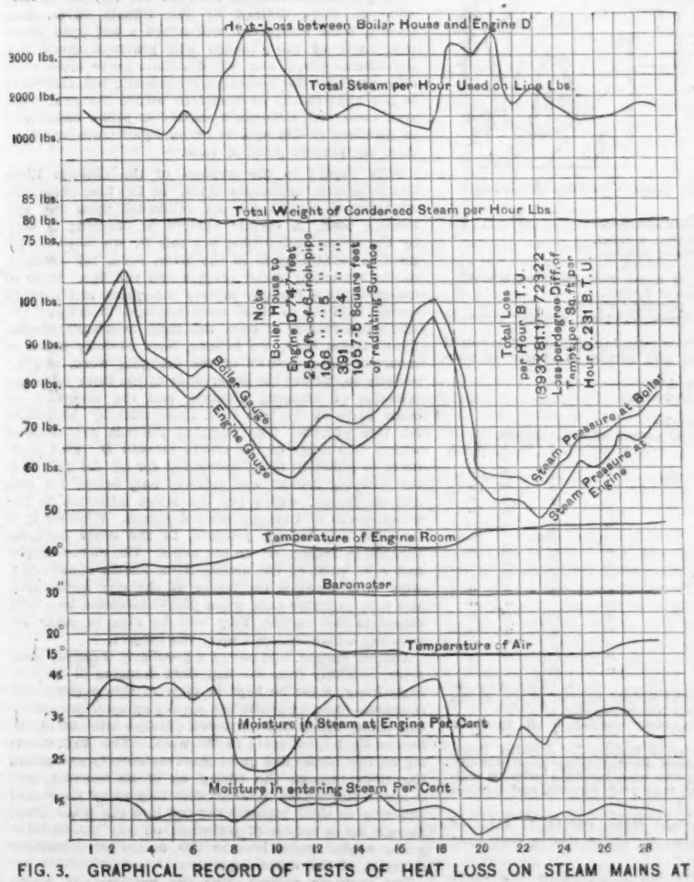


FIG. 3. GRAPHICAL RECORD OF TESTS OF HEAT LOSS ON STEAM MAINS AT SOUTH PLAINFIELD COAL STORAGE PLANT, LEHIGH VALLEY R. R.

(It appears from the tables that the titles of the two lower lines of the diagram should be transposed, but they are arranged as shown in the cut furnished us.)

Simultaneous observations of the quantities given in the tabular summary were taken every ten minutes. It will be seen that the loss was sensibly constant during the run. This is clearly shown by noting the fact that any increase in the amount of steam flowing through the line had the effect of decreasing the percentage of moisture at the engine.

The steam is conveyed to the engines in piping, which is protected from heat radiation by Wyckoff covering as now manufactured at Elmira, N. Y., by A. Wyckoff & Son. It consists of two concentric octagonal pipes, each built of 1-in. plank, and separated from each other by a very thick layer of water-proof paper. Fig. 2 shows this covering with a portion of the outer layer removed, to show the paper. The steam pipe is laid in the center of the wooden pipe, and is surrounded by a ½-in. air space.

At South Plainfield, because of the wet character of the soil and the difficulty of securing proper drainage, the pipe was left on top of the ground, and protected by a rough wooden box constructed of 2-in. plank. The outer box is far from tight, and air enters freely at numerous cracks and holes, so that, except as a mechanical protection for the inner wood covering, it cannot be considered of great value, and is certainly inferior in non-conducting properties to a covering of earth.

The boilers for the plant are six in number, and are a vertical type of plain tubular boiler, built by Stearns Mfg. Co., Erie, Pa. They are 6 ft. in diameter, 18 ft. high, and contain 316 3-in. flues. Four of the boilers are sufficient to operate the plant at its usual capacity.

The expansion of the line is poorly provided for, there being one plain expansion joint and two offsets. The expansion joint is badly out of line, is located near the boiler-house, and is practically inoperative. The result is that, when a given line is heated up, a great increase of length occurs, which is permitted by the branches leading to the various engines, but which, nevertheless, induces severe strains both in the pipe itself and in the outer wood covering.

The test of heat losses was made by myself, assisted by Messrs. Dunn and Mack, of the class of 1893, in Sibley College, Cornell University. The test was made only of the west line, and was confined to measurements of the loss of heat between the boiler-house and the three engines taking steam from it. The test was made Feb. 17, 1893, and was of eight hours' duration.

The total loss per hour was equivalent to that required to evaporate 81.1 lbs. of water from 212° F., to a gage pressure of 70.1 lbs. This is equal to (81.1×893 =) 72,322 B. T. U. The average steam pressure was 70.1 lbs., its temperature 313.6° F., the average outside temperature 16.6° F., hence the difference of temperature was 297°. The loss for each degree difference of temperature becomes 72,322 ÷ 297 = 244.2 B. T. U. per hour. The total radiation surface was 1,057.5 sq. ft., hence the loss per sq. ft. per hour was 0.2315 B. T. U. per degree difference of temperature.

The rate of loss for a naked steam pipe under the same conditions would have been 2.93 B. T. U., or the loss of the covered pipe is reduced to 7.87% of the bare steam pipe. The entire loss for the transmission is equal to the coal needed each hour to evaporate 81 lbs. of water, which can be approximately stated as 10 lbs. Expressed as a percentage of maximum capacity of the line this loss will not exceed 1%, although it reached 2.3% of the maximum heat transmitted during the test.

The diagram, Fig. 3, shows the variation in the various quantities which occured at each observation during the test. It will be noted that the total loss expressed in pounds of steam condensed remained practically constant. This has the effect of decreasing the percentage of moisture present in the steam when the total amount of steam passing through the line increased. It is also of interest to note the parallelism of the two lines which represent respectively the pressure at the boiler and at the engine, nearly 750 ft. distant.

These figures compare favorably with any other method of power transmission, even when the fact is considered that the line during the winter months is kept hot night and day, while the power is actually used only during the day. This would not at the most more than double the loss, and even if considered would not make the loss in power transmission exceed 5% of the power required to do the work.

The following is a comparison of the results obtained by the two methods of protecting steam pipe: Column A is for pipe underground and protected by solid wood piping with shell 4 ins. thick. Column B is for pipe in square wooden box and protected by the Wyckoff covering 2 ins. thick.

	A.	B.
Loss in B. T. U. per sq. ft. of surface, and per degree difference of temperature	0.614	0.231
Per cent. that loss bears to that of a naked steam pipe under the same conditions	30.7	7.9
Relative value of covering	1	2.66

The loss in transmitting power by any system is largely constant, and hence when the power is greatly increased the percentage is correspondingly reduced. The following estimate is based on the transmission of 100 HP. 1,000 ft.:

Method of transmission.	Percentage of loss.
Line shafting:	
Loss by friction (average 25)	15 to 40
Electricity*:	
Loss in transforming from mechanical to electrical and vice versa	20 to 30
Line loss	2 to 5
Total loss	22 to 35
Conveying steam:	
Naked steam pipe (still air)	37.6
Pipe covered with solid wood and earth	11.2
" " " " Wyckoff's covering.	4.2

It is easily possible to calculate the surface required to condense 1 lb. of steam from the data given in the tests. Thus, to change 1 lb. of steam at atmospheric pressure into water at a temperature of 212° 967 B. T. U. must be absorbed. Since the table above gives the loss caused by each square foot of surface for a difference in temperature of one degree between the steam in the pipe and the medium outside, we have only to divide 967 by the product of the number representing the difference of temperature and that showing the loss. Calculation made in this manner gives the following values for the amount of surface expressed in square feet required to condense 1 lb. of steam per hour:

Surface Required to Condense One Pound of Steam per Hour:

	Difference of temperature between steam and air.		
	1°.	180°.	200°.
Condition of pipe.	Sq. ft.	Sq. ft..	Sq. ft.
Naked pipe	483	2.7	2.4
Pipe, protected as in Fig. 1	1,570	8.7	7.8
Pipe protected with Wyckoff covering, as in Fig. 2	4,170	22.1	20.8

At Cornell University the various buildings had been heated by separate plants before the introduction of the system described. After the introduction of the new system it was found that, despite its large wastes, the buildings were heated better and more economically than before; chiefly due to the fact that the new boiler plant was made

* Professor Carpenter's figures for loss in electrical transmission seem rather large. The best dynamos and motors now work at an efficiency above 90%; perhaps 15 to 25% would be a fairer statement than the 20 to 30% which he gives.—Ed.

more efficient, and was arranged so that a cheap grade of coal could be successfully burned. Yet, as shown by the foregoing tests, the heat losses might have been reduced by a better covering to less than 40% of those actually found.

THE LONDON "LANCET" ON CHICAGO'S WATER SUPPLY AND SEWAGE DISPOSAL SYSTEMS.

In view of the large number of people who will go from England to Chicago this year to attend the World's Columbian Eposition, and the reports regarding the bad quality of the Chicago water supply, the London "Lancet" has made an investigation of the latter, which it presents in its issue of April 8. Over 17 pages of the "Lancet" are devoted to the subject, presenting a general description of Chicago's water supply and sewage disposal systems, and the results of chemical analyses of water from Lake Michigan, the Chicago River and of drinking water taken in the city. The general conclusions of the "Lancet's" article were given in our issue of April 6, and briefly commented on in our issue of April 20, 1893.

This report contains a very good description of the Chicago water-works and sewage disposal systems as they were at the beginning of this year, much of it just as compiled by City Engineer Dion Geraldine. We have slightly condensed this part of the report as follows:

The water supply of Chicago is drawn from Lake Michigan by a number of pumps distributed over the city. The water is neither stored nor filtered, but distributed exactly as drawn, and may therefore be expected to exhibit when served out for use the characters of the lake water in those parts of the lake from which it is derived. The city extends for some 20 miles along the shore. It comprises an area of about 180 square miles, having, therefore, an average breadth inland from the lake of about nine miles. This area includes large districts that are only very sparsely populated, but in its more central parts the population is very dense, and the whole amounts at the present time to nearly a million and a half.

The pumping stations are six in number, and constitute three systems, which may be appropriately described as the northern, central and southern systems, respectively. This statement ignores a small supply drawn from an artesian well, which serves the recently annexed district of Washington Heights.

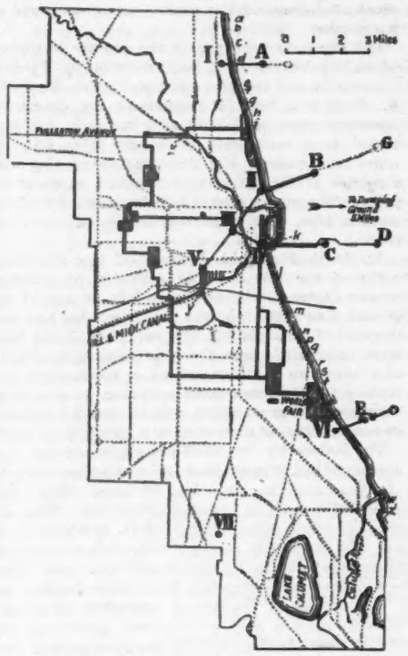
Before proceeding to describe the water intakes we may with advantage deal with the sources, or rather channels, of pollution. These also may be divided into three groups, viz.:

1. The Chicago River.
2. The Calumet River.
3. The sewers draining the lake shore districts.

With respect to the rivers it may be explained that they serve as main sewers to the districts through which they flow; the sewers upon the lake shore pour their contents without treatment of any sort into the lake.

Of these three channels of sewage pollution, the most important by far is the Chicago River; and so far as this is concerned, an attempt has been made to mitigate the evil of lake contamination by means of an artificially induced current, which flows from the lake into the river. This current is maintained by pumps situated on the southern branch of the river, which pump the river water over a dam (y in the map) at the rate of 52,000 cu. ft. a minute. This operation enables it to find its way into the Illinois River, which belongs to the Mississippi system; so that ultimately the drainage of the Chicago River, diverted from its natural course, finds its way into the Mississippi, and so into the ocean. In seasons of storm and heavy rain the Chicago River follows its natural course, and in spite of pumping operations pours its contaminated water into the lake. But this is exceptional; in ordinary circumstances the pumps prevail, and induce in the southern branch of the river a flow which toward the end of the river attains to a speed of about one-third of a mile an hour. In another way, however, the river is a source of much more serious contamination to the lake. Its current being so slow as it is, and its water being surcharged with sewage matter in suspension, there is naturally a considerable deposit of solid matter in its channel, which has to be kept clear by constant dredging. The sludge taken from the river bed is deposited in the lake five miles from the shore, and gives rise, of course, to serious pollution of the lake water in the vicinity of the dumping ground.

The Calumet River is less considerable as a source of pollution than the Chicago River, for the simple reason that it flows through a district much less densely populated than does this matter. From our present point of view it demands consideration on account of the circumstance that it debouches into the lake at no great distance from the spot where the Exhibition is to be held, and is the principal source of contamination of the southern water supply, upon which the Exhibition will be dependent. It will be seen from the letter of Mr. City Engineer Geraldine, to Mr. Commissioner Kuhns, of the 4th ult., which appears further on, that the sewage of the Calumet cannot pass into



Map Showing Water Supply Systems of Chicago.

Explanation.

I. Lake View pumping station.
II. North Side pumping station.
III. Central pumping station.
IV. Fourteenth St., or South Side pumping station.
V. West Side pumping station.
VI. Sixty-eighth St. pumping station.
VII. Washington Heights pumping station (artesian well).
A. Intake for Lake View pumping station. The dotted line indicates a tunnel and intake in course of construction.
B. Intake off Chicago Ave.
C. Two-and-a-half-mile intake.
D. Four-mile intake.
E. Sixty-eighth St. intake.
G. Tunnel and intake in course of construction.

a. Grand Ave.	sewer outfall,	4	ft.	in diam.
b. Bryn Mawr	"	4	"	"
c. North Fifty-ninth St.	"	4	"	"
d. Lawrence Ave.	"	4	"	"
e. Graceland Ave.	"	2	"	"
f. Grace St.	"	3	"	"
g. Roscoe St.	"	3	"	"
h. Belmont Ave.	"	2½	"	"
j. Surf St.	"	3	"	"
k. Twelfth St.	"	5	"	"
l. Twenty-second St.	"	6	"	"
m. Thirty-fifth St.	"	6	"	"
n. Forty-first St.	"	4	"	"
p. Forty-third St.	"	2½	"	"
q. Forty-fifth St.	"	4	"	"
r. Fifty-first St.	"	5	"	"
s. Fifty-third St.	"	2½	"	"
t. Fifty-sixth St.	"	4½	"	"
v. Strand		5.		

(This is not indicated on the map, as the Strand district is not shown on any map of Chicago in our possession.)

w. South Chicago Ave.	sewer outfall,	5	ft.	in diam.
z. Ninety-fifth St.	"	4	"	"

x. Fullerton Ave. pumping station for flushing river.
y. Canal pumping station, for reversing river current.

The dotted lines upon the map inland represent railways. In the lake they represent tunnels and intakes in course of construction.

Lake Michigan in a crude state, except in time of flood; but as to the means by which this is prevented we have no information.*

The lake shore sewers are indicated by the small letters, a to z, in the map. Concerning them it is not necessary to add more than that they discharge their contents untreated into the lake.

It will now be easy to work out the bearing of this sewage discharge upon the water supply, regard being had to the positions in the lake from which the various systems draw their water.

The northern system pumping station, situate in Sulzer St., is marked I. upon the map, and a tunnel and intake crib—the latter marked A—are shown. This intake is placed rather more than a mile from the shore. Another crib, also shown by broken outlines on the map, will shortly be brought into use, it is hoped, during the coming summer. It will be situated 10,500 ft. from the shore. This northern system is not, from our point of view, a matter of great importance. It supplies a district remote from the principal railway stations, and from the Exhibition, and will therefore be but little frequented by visitors.

The central system, which comes next in local order, is the largest and most important of the three, since it supplies not only the greatest part of Chicago, but also that part in which probably the great majority of the English visitors will dwell during their sojourn in the city. It comprises the four pumping stations marked II., III., IV. and V., in the annexed map, which are interconnected, as shown, and obtain supplies from three cribs marked B, C and D on the map. The chief source of contamination here is the Chicago River, which affects the intakes in two ways: In the first place by its outflow carrying suspended sewage matters, and in the second by the deposit in the lake of the river sludge dredged from its channel. Reference has already been made above to the expedient by which a reversed current is induced in the river by means of pumps situated at the station marked y on the map, which transfer the water into the Illinois Canal. These pumps are apparently effective to the extent of preventing the flow into the lake of the very foul water which accumulates from the stockyards and other sources of pollution in the southern branch of the river. The northern branch of the river is swept by a stream pumped into it at Fullerton Ave.—the point marked x on the map—where powerful pumps discharge lake water into the river at an average rate of 10,000 gallons a minute. Operations are in progress at the present time for superseding the canal pumping station y by means of a deepened channel cut across the high ground intervening between the city of Chicago and the slope drained by the Illinois River. This trench, when completed, will afford a bed upon which the water of the Chicago will gravitate down into the Illinois River, and will doubtless prove much more efficient than the present arrangement; but this work is not expected to be complete before the year 1895, and, therefore, although a matter of prime importance to dwellers in Chicago, is of no significance whatever from our present point of view.

With regard to the disposal of the Chicago River sludge greater difficulties arise. In the first place, the dredging operations are not conducted upon any systematic plan. A certain amount of dredging is done by the urban authorities; but this is, we believe, confined to certain spots in the river, such, for example, as the waterway under bridges and the like. Much of the dredging is done by private enterprise, and it is, of course, difficult in those circumstances to enforce the strict observance of even the most necessary precautions. Steps have, we believe, been recently taken to secure a better control of the dredging work, and especially to enforce the observance of the rules as to the selection of dumping grounds, and the avoidance of other parts of the lake than those officially designated for this purpose. The pumping grounds are situated within two miles of the intake marked D. This proximity is probably to be accounted for by the fact that the dumping ground was selected long before the crib and its tunnel, which are the latest additions to the water-works of Chicago, were designed. Whether it is intended, or, indeed, possible, to use other dumping grounds in future, we do not know. The inconvenience and even peril of the arrangement shown cannot possibly have escaped the notice of the city authorities, and it is probable that when public attention has been called to the matter, they will be able to make reassuring announcements upon the subject.

Another danger, and one of a peculiarly insidious character, resulting from the imperfect dredging of the Chicago River, must be kept in view in this inquiry. An enormous shipping traffic has sprung up upon the American lakes, which has converted Chicago into one of the five or six largest ports in the world. The craft carrying on this traffic find great inconvenience in navigating the river through the silting up of its channel, and it seems impossible to doubt that they carry river mud adhering to their bottoms far out into the lake. This, though not a source of pollution, on any considerable scale, might easily become the means of occasional infection of the water supply.

The southern system, like the northern, is represented by a single pumping station, marked VI. upon the map. Its intake is marked E, and situated about one mile from the shore, with which it is connected by a tunnel of 6 ft. diameter. The single station is equipped with very powerful machinery, to which an addition has recently been made of pumps which will deliver 24,000,000 gallons daily, this being the estimated requirement for the special purposes of the Exhibition. This intake is exposed to contamination both from the south shore sewers and the Calumet River, and its position is, we believe, considered by the city authorities to be for this reason unsatisfactory. Such as it is, however, it is the source from which must be derived the water to be supplied in Jackson Park and the entire southern district of Chicago. This, therefore, is, next to the central supply, that which most nearly concerns visitors to the Exposition. Within the Ex-

(* The Calumet River flows to or from Lake Michigan according to the varying stages of water in the lake and river.—Ed.)

position grounds the lake supply will be supplemented by an entirely independent service of spring water provided by the Waukesha Hygeia Mineral Spring Company, which has laid extensive water mains for distributing, and has connected its spring at Waukesha with the Exposition grounds by something like 116* miles of water pipe. This water is to be sold at one cent a glass.

The following letters have been kindly forwarded to us by the Mayor of Chicago as comprising a full statement of the systems of drainage and water supply of the city of Chicago, together with the observations of the medical officer of health upon the sanitary condition of the city:

Department of Public Works, March 2, 1893.

E. Louis Kuhns, Esq., Commissioner:

Dear Sir: Complying with your request of Feb. 20, and penciled memorandum thereon, I beg to present a general report of the water resources of the city of Chicago, together with an outline map showing pump stations, tunnels and cribs, referring also to contemplated improvements.

The total pumpage for 1892 was 71,035,462,221 gallons, an average of 195,000,000 gallons per day, distributed through the mains as potable water by means of seven pumping stations:

1. Lake View.
2. North Side.
3. Central.
4. Fourteenth St.
5. West Side.
6. Sixty-eighth St.
7. Washington Heights.

1. Lake View.—Located at the corner of Sulzer Ave. and Halstead St., containing the following engines:

Style.	Date.	Capacity.
Gaskill horizontal	1892	12,000,000
" "	1886	12,000,000
Worthington horizontal	1882	5,000,000
Flanders "	1892	2,000,000
Daily capacity		31,000,000

This station is fed by a 6-ft. brick tunnel, the temporary intake of which, now in use, is at a distance of 6,500 ft., and the permanent intake of which, to be opened during the summer of 1893, will be at a distance of 10,000 ft. from shore. It is contemplated to have in the northwesterly part of the city another large pumping station, to be connected with the lake by means of a land tunnel joined to the existing lake tunnel system opposite Chicago Ave.

2. North Side.—Located at the intersection of Chicago Ave. and Pine St., containing the following engines:

Style.	Date.	Capacity.
Pittsburg double beam	1872	36,000,000
" " "	1867	18,000,000
Gaskill, two double horizontal	1886	24,000,000
" single beam	1857	12,000,000
" " "	1853	8,000,000
Daily capacity		98,000,000

The two last-named engines are not very often used now, and it is the intention to install in their place in the near future more powerful and modern engines. This station derives its water from the original crib two miles out in the lake, the connection being two brick tunnels, 5 ft. and 7 ft., respectively, in diameter. There is also an emergency tunnel 7 ft. in diameter, leading to a new crib on the northwest end of the outer government breakwater.

3. Central.—Located on Harrison St., between Harrison and Desplaines sts., completed in 1891, and containing the following engines:

Style.	Date.	Capacity.
Allis triple expansion	1891	18,000,000
" "	1891	18,000,000
Daily capacity		36,000,000

This station is connected both with the land tunnel, 7 ft. in diameter, leading to the West Side station, and with the 7-ft. land tunnel, which is a ramification of the new four-mile lake tunnel, described subsequently.

4. Fourteenth St.—Located at the corner of Fourteenth St. and Indiana Ave., in 1891, deriving its water from the new four-mile tunnel through an 8-ft. land ramification, but also connected with the old 7-ft. land tunnel by means of a tunnel tapering from 5 ft. to 2½ ft. on Desplaines St., and a 6-ft. tunnel on Jefferson St., and containing the following engines:

Style.	Date.	Capacity.
Allis triple expansion	1892	18,000,000
" "	"	18,000,000
" "	"	18,000,000
Daily capacity		54,000,000

Space remains for another engine of at least the same capacity as the present ones, which should be arranged for as soon as possible.

5. West Side.—Located at the intersection of Ashland Ave. and Blue Island Ave., completed in its first half in 1876, and containing the following engines:

Style.	Date.	Capacity, in gallons.
Double beam Corliss	1876	30,000,000
" "	1883	30,000,000
Daily capacity		60,000,000

It derives its water from the original two-mile crib by means of an extension across the town of the 7-ft. brick tunnel mentioned above as feeding the North Side station.

6. Sixty-eighth St.—Located at the corner of Sixty-eighth St. and Ogiesby Ave., whence a 36-in. water main has been laid to supply water to the World's Columbian Exposition, which will be an independent and direct connection, with two new Gaskill engines of 12,000,000 gallons capacity each, thus being enabled to send the entire output to the Exposition grounds if needed. This station now contains the following engines:

Style.	Date.	Capacity, in gallons.
Cope-Maxwell	1882	6,000,000
Gaskill	1886	12,000,000
"	1888	12,000,000
"	1892	12,000,000
"	1892	12,000,000
Worthington	1890	12,000,000
Holly vertical	1881	8,000,000
Knowles	1878	3,000,000
Daily capacity		77,000,000

It is proposed to do away as soon as possible with the 6,000,000 gallons Cope-Maxwell, the 8,000,000 Holly vertical and the 3,000,000 Knowles, all of which are out of date, out of repair, and expensive in operation, and to replace them with a single high-duty modern pumping engine of about 18,000,000 gallons capacity. This station is fed by a 6-ft. lake tunnel off Sixty-eighth St., details of which are given under the heading "Tunnels."

7. Washington Heights.—Located on Vincennes Ave., near 104th St., and deriving its water from an artesian well of a daily capacity of 500,000 gallons.

Pumping Plants for Cleaning the Chicago River.

The Fullerton Ave. station, of a capacity of about 12,000 cu. ft. per minute, erected in 1879 at Fullerton Ave. and the north branch of the Chicago River for the purpose of flushing the latter, draws fresh water from the lake through an intake off Fullerton Ave. and a cross-town 12-ft. tunnel, and houses a vertical engine with horizontal shaft bearing two propeller wheels, which force the lake water into the river against a head of about 2 ft., and this creates a flow in the north branch toward the junction with the main river, and thence down the south branch towards the canal pumping station.

The Canal Pumping Station, located at Ashland Ave., near the Illinois & Michigan Canal, was erected in 1882 for the purpose of lifting the contents of the Chicago River into the Illinois & Michigan Canal at the rate of 60,000 cu. ft. per minute. It houses four sets of centrifugal pumps of a nominal capacity of 15,000 cu. ft. per minute each, which are now being exchanged gradually for four sets of undulating pumps of a contract capacity of 25,000 cu. ft. per minute each against a head of 6 ft., under a contract with the Courtwright Hydraulic Machinery Co. The term of completion is July 8, 1893, so there would be a capacity of 100,000 cu. ft. per minute from that day on.

Tunnels.

Of these there are four systems:

1. Lake View.
2. Two Mile.
3. Four Mile.
4. Sixty-eighth St.

1. Lake View.—Mentioned under the heading of Lake View pumping station. This is a 6-ft. tunnel, and has a capacity of 72,000,000 gallons per 24 hours.

2. Two Mile.—The tunnels terminating at the two-mile crib have a diameter of 5 ft. and 7 ft. respectively, as mentioned above, and an aggregate daily capacity of 158,000,000 gallons. If the shore gate of the 7-ft. inlet tunnel terminating at the exterior government breakwater (see under North Side pumping station) were to be opened fully, the aggregate capacity would be upwards of 220,000,000 gallons, one-half of which would be furnished by the short emergency tunnel. This has never been done. It is contemplated to extend this 7-ft. shore inlet tunnel to the two-mile crib, join it with the 5-ft. and 7-ft. tunnels, terminating there into a single 13-ft. or a double 10-ft. tunnel, and extend the system thus simplified to a point 4½ miles from shore, where a new intake would be constructed. The capacity of this system would be 270,000,000 gallons per 24 hours.

3. Four Mile.—The new four-mile tunnel, which was completed in November, 1892, has a diameter of 8 ft. and a daily capacity of 140,000,000 gallons. The new pumping stations on Fourteenth and Harrison sts. derive their water from this tunnel, as mentioned above.

4. Sixty-eighth St.—This tunnel has its present (submerged) intake one mile from shore, a diameter of 6 ft. and a capacity of 72,000,000 gallons. For the purpose of improving the quality of the flow it is being extended as a 7-ft. tunnel to a point two miles from shore, under a contract with Messrs Lydon & Drew, of this city, which sets the date of completion of the new work and of filling the extended tunnel with water from the new intake at Feb. 20, 1893. The city intends to establish, in addition to the two cribs and shafts with three working faces provided in the contract, two more cribs and shafts, increasing the number of working faces to seven, and thus expects to pump water from the new intake by July, 1893. The quantity of the flow is not altered by the extension.

Summary of Present Capacities.

I.—Water pumping stations.

	Gallons.
1. Lake View	31,000,000
2. North Side	98,000,000
3. Central	36,000,000
4. Fourteenth St.	54,000,000
5. West Side	60,000,000
6. Sixty-eighth St.	77,000,000
7. Washington Heights (artesian well)	500,000
Total capacity for 24 hours	356,500,000

II.—Tunnels.

	Gallons.
1. Lake View	72,000,000
2. Chicago Ave.	220,000,000
3. Four-mile	140,000,000
4. Sixty-eighth St.	72,000,000
Total capacity for 24 hours	504,000,000

Yours truly,
Dion Geraldine, City Engineer.

Department of Public Works, March 3, 1893.

E. Louis Kuhns, Esq., Commissioner.

Dear Sir: I beg to supplement my report of this morning with the following, relative to the sewage of the city. About 85% of the entire sewage of the city is discharged into the Chicago River, thence by the agency of the Canal pump works through the Illinois & Michigan Canal into the Desplaines River, and thence into the Mississippi.

Yours truly,
Dion Geraldine, City Engineer.

Department of Public Works, March 4, 1893.

E. Louis Kuhns, Esq., Commissioner.

Dear Sir: Eighty-five per cent. (85%) of the total sewage of the city, and especially the whole of the sewage of the business and manufacturing parts of the old city, is discharged into the various branches of the Chicago River, and, indirectly, by means of the Bridgeport Canal pumping station, aided by the Fullerton Ave. flushing station, both of them described above, into the Illinois & Michigan Canal, thence into the Desplaines River, thence into the Illinois River, thence into the Mississippi River.

By far the greater portion of the remaining 15% of the total sewage of the city is furnished by districts devoted exclusively to residence and park purposes, and is discharged directly into Lake Michigan through sewer outfalls, distributed along a shore line 20 miles in length.

A very small portion of the 15% of the total is furnished by the manufacturing district in the Calumet basin, and is discharged into the Calumet River, whence it cannot pass in its crude condition into Lake Michigan except in time of flood.

The Board of Trustees of the Sanitary District of Chicago are now constructing, under authority of an act of the legislature of the state of Illinois, a combined drainage channel and navigable waterway of very large dimensions, which, when completed, will carry a gravity flood of 600,000 cu. ft. per minute from Lake Michigan through the Chicago River, and eventually, it is expected, through the Calumet River, also into the Desplaines, Illinois and Mississippi rivers, superseding the present Illinois & Michigan Canal. It is intended to carry intercepting sewers along the lake shore, and to discharge them into the river flow away from the lake. In this manner Lake Michigan will be protected absolutely and at all times against the entrance of any sewage from the city of Chicago.

Yours truly,
Dion Geraldine, City Engineer.

ALLOYS.

At the meeting of the Institution of Mechanical Engineers, in London, April 20, 21, as noted in another column, Prof. W. C. Roberts-Austin presented the second report to the Alloys Research Committee, which was a continuation of previous work treated of in his first report, published in the Proceedings for 1891 (p. 543). The object of the investigation was to extend a research previously made by the writer upon the application of the "periodic law" of Newlands and Mendeleef to the mechanical properties of metals. The following is an abstract of the report, sent us by our London correspondent:

As originally expressed, this law states that "the properties of the elements are a periodic function of their atomic weights." The author pointed out that it had already been shown that the effect of impurities added to gold is nearly proportional to their atomic volumes, the larger the volume of the atom the greater being its effect; and the question was: Does this hold good for other metals? It was manifest that the most important evidence which could be gained was that relating to the thermal disturbance which accompanies any molecular change; and, as this usually occurs at high temperatures, it was necessary to develop and perfect the methods which were available for measuring them, and for recording the results. The "First Report," therefore, dealt with the description of certain new methods and appliances which had been adopted in conducting the inquiry, the most important being a photographic method of pyrometry. Before describing the experiments that have been

(* 104 miles.—Ed.)

made, the author directed attention to further considerations which seem to point to the possibility that the influence of small quantities of added elements on the mechanical properties of masses of a metal will be in proportion to the atomic volume of the impurity. Continuing, he said that the mechanical properties of copper are known to be strangely affected by the addition of foreign matter. The results already obtained with iron at once suggest the question whether copper is a metal whose ultimate atoms are capable of arrangement in different ways in the molecule. Can normal copper be made to assume an allotropic state analogous to that in which there is reason to believe iron can exist? If it can, are the properties of normal and of allotropic copper as widely different from each other as are those of the distinct varieties of certain well known non-metallic elements? There seems to be little doubt, according to Schuetzenberger, that copper can be prepared by electrolytic deposition in an allotropic state, in which the density of the metal is from 8.0 to 8.2, as compared with 8.92, which is that of normal copper; the allotropic variety also shows a readiness to undergo chemical change which is not shared by ordinary copper. The evolution or absorption of heat, however gradual during cooling or heating, which is evidence of marked reversible thermal effects, and is a main indication of molecular change, is not so easy to detect in copper as it is in iron which is being gradually cooled or heated. On the other hand, Mr. Osborn holds, in the case of iron, that, subjecting the metal to any mechanical stress which tends to produce permanent deformation of the mass enables the iron to assume an allotropic form. In this respect the purest obtainable copper seems to be singularly sensitive, inasmuch as its subjection either to stress, which deforms the metal, or to annealing, the tendency of which is to reverse the effects of mechanical stress, is accompanied by profound changes in the mechanical properties. It is impossible to say, for instance, what the standard tenacity of a normal sample of pure copper should be taken to be, as so much depends on the previous history of the piece of metal, especially as regards the mechanical and thermal treatment to which it has been subjected. The variations may be considerable, as exhibited by Mr. Osborn's experiments, and in which there was great difference in the breaking stresses per square inch of rods of pure electrolytic copper of the same metal, but variously treated. The experiments made with these copper rods entirely confirm the results obtained in England by Mr. Parker and Professor Unwin. The great difficulty of determining what should be the standard tenacity of copper was well illustrated by the results obtained by the American committee appointed some years ago to investigate the properties of the alloys of copper and tin. Even if a standard tenacity could be fixed, it would be very difficult to get a sufficient quantity of copper of a standard degree of purity for the purposes of a lengthy inquiry.

As the material which formed the basis of the experiments, the author adopted pure electrolytic copper cast in thin rods, prepared in a special manner. Owing to the difficulty of making small castings of copper, due to the rapidity with which oxidation proceeds when the liquid metal is exposed to the air, as it is when poured into a mold, and in order to exclude the simultaneous presence of cuprous oxide (which singularly affects the strength of copper), the molten metal was not brought into contact with the air at all, but the molds formed part of the crucible in which the metal was melted. In the preparation of the copper rods, they were first carefully and evenly hammered until they were somewhat flattened. They were then heated to redness for a few minutes, and plunged into cold water, and hammered until they were of square section. They were again heated to redness and quenched, and then hammered until they were octagonal. They were finally brought to an approximately circular section by passing them through grooved rolls. After a third heating and quenching, their diameter was measured by means of a micrometer, and marks were made at every half inch of their length. They were then ready for testing. The test pieces were loaded at such a rate that fracture occurred in about 15 minutes from the first application of load. The copper was analyzed and found to be singularly pure, containing 99.99% of copper. Neither lead, silver, antimony, arsenic, tin, iron, nickel, sulphur, nor phosphorus could be detected, although they were carefully sought for. On the other hand, a minute trace of bismuth was detected. The electrical conductivity of this metal after annealing was very high, being found by Mr. W. Gowland to be 102, pure copper being usually 100 or 101. A small hydraulic machine of the single lever type was used for making the tests. The load was applied by a hydraulic ram, and measured by weights carried at the end of a bell-crank lever working upon steel knife edges. The maximum tension that could be exerted on the specimen was two tons, and the leverage was twelve times. The little appliance used for determining the limit of elasticity consists of a frame carrying two multiplying levers, to the second of which is attached a mirror. A ray of light is allowed to fall upon this in a direction parallel to the axis of the machine, and is reflected upon a scale 50 ins. distant. The frame is supported upon three hardened steel screws, two of which are sharpened and rest in slight centers punched in the test rod, being held in them by spring clips. One of these two screws is, however, connected to the frame by means of the first of the multiplying levers; and hence, any elongation of the rod is greatly multiplied by the mirror to 2,000 times. The total length of each specimen was about 7 ins., and the length between the jaws was 4 ins. The calculations for the strength of the rods were made both upon the original and upon the final areas which the rods assumed before fracture; but the final section was not in all cases easy to determine. The rods usually fractured in one of two ways. Either the rod broke suddenly, when the case presented no difficulty; or sometimes the metal did not break until it had become drawn out to a fine knife-like edge. In the latter case, the beam of the machine dropped rapidly, and in some trials it was found that, by carefully measuring the place of stricture, and then applying again a diminished load, further extension did not occur until the load per unit of area of the construction equaled the maximum load that had been previously applied to the rod; and that when this load was exceeded, a further rapid constriction would occur. On account of this fact, in all cases where such rapid flow occurred, the area taken for calculation was that of the rod immediately prior to the constriction taking place.

Coming to consider the results of the tests, as set forth in tabular form and by curves plotted in diagram, the author first referred to the effect of arsenic on copper. The tenacity of pure copper at 300° C. or 570° F. is 9.38 tons per sq. in., with an elongation (according to A. Le Chatelier) of 34.6%; whilst that of arsenical copper (the copper containing 0.2% of arsenic), according to the results of the experiments now published, is 28,230 lbs., or 12.6 tons per sq. in. at that temperature. It appears safe to conclude, says the professor, that the superior strength and ductility of arsenical copper is maintained at the temperatures attained by the plates of the fireboxes of locomotives; and that it is harder than pure copper. This would explain the preference of the makers of locomotive fireboxes for old brands of copper, supplied before the elimination of arsenic was so fully understood by smelters. This is borne out by some experiments made by Professor Hampe, who has studied the effects of arsenic, antimony and silicon on pure copper. He employs very pure copper in the form of wire, having an initial tenacity of 49,120 lbs., or 21.03 tons per sq. in.; and shows that the effect of the presence of 0.351% of arsenic is to raise its strength to 72,380 lbs., or 32.26 tons; while with a larger proportion, 0.808% of arsenic, the strength is somewhat less, namely, 69,380 lbs., or 29.7 tons. The influence of antimony appears to be even more marked, the strength of copper with 0.26% and 0.529% being respectively 73,800 lbs., or 32.96 tons, and 77,900 lbs., or 34.77 tons. No attempt was made to ascertain the strength of these alloys at temperatures higher than those of the atmosphere. A curious form of fracture was exhibited by the rods containing bismuth. All exhibited a more or less quasi-fibrous fracture, and rather suggested that of a network of cells; but in a few cases a very fine surface, as of cleavage planes, was the result. The result of Professor Hampe's experiments just referred to would seem to show that antimony behaves like arsenic, and when present in small quantity greatly strengthens the copper. Bismuth, on the other hand, as the experiments submitted to the Committee show, renders copper singularly weak; and the peculiar behavior of bismuth pointed to the necessity for a very close examination of its mode of action. For instance, copper containing 0.1% of bismuth was found too brittle to work, and it has at the ordinary temperature a tenacity of 18,000 lbs., or about 8 tons per sq. in.; and when the members of the series are tested at graduated rising temperatures, the fall in tenacity is very rapid, and there is practically no elongation. The author says that it would appear that however poor or however rich in bismuth the alloy with copper may be, a portion of bismuth, containing perhaps a little copper, always remains fluid until the temperature of the mass has fallen to 268 C., or 514 F.—the point at which bismuth itself solidifies. The presence of a fluid constituent in an alloy, long after the mass itself has become solid, is doubtless the determining cause which enables the metal to assume a highly crystalline, and, consequently, an intensely brittle structure. Experiments are in progress with a view to ascertain in what order impurities hinder the restoration to copper of its original strength and ductility, after it has been strained beyond the limit of elasticity.

The passage of iron from one allotropic modification to another is accompanied not only by a change of heat capacity, but also by a change of volume. When a mass of iron cools down from a temperature of 1,000 C. or 1,800 F. it also contracts, until at the point of recalescence it suddenly expands, after which it again contracts as it cools to atmospheric temperature. An experiment described in the "First Report" indicated the probability that pressure lowers the critical points of iron and steel. From three sets of experiments made since then with blocks of steel, it is evident that the recalescence point is lowered by pressure, but it was found that this lowering is not effected unless the load is applied at a temperature well above that at which recalescence takes place.

In the general conclusions, Professor Austen, who in his investigation has been assisted by Messrs. Jenkins and Stansfield, says that it may be asked, What evidence has been gathered as to the mode of action of added elements? and does it appear that the atomic volume of the added element has a dominating influence upon the mechanical properties of the mass in which it is hidden? In attempting to answer these questions, grave complications arise from two causes in the case of copper. First, it is doubtful whether the copper does or does not exist in more than one state; and the passage of the metal from one state to the other may be determined by the presence of an added element. Second, it is difficult to insure that a small quantity of an added element should remain unoxidized in the mass of copper—a difficulty which is of far less magnitude in the case of the experiments with gold. The true action of an added element may thus readily be masked by its action as a deoxidizer. Notwithstanding these difficulties, it is undoubtedly proved that bismuth, potassium and tellurium—all of which have large atomic volumes—greatly lower the tenacity of copper. Arsenic, which has a larger atomic volume (13.2) than copper (7.1), confers strength on copper; but it is very certain that the limit of elasticity and the ductility of a metal are greatly influenced by the presence of such of the elements with large atomic volumes as have thus far been studied; and this fact may be of more molecular significance than the diminution of tenacity, to which, for the sake of simplicity, attention was mainly directed when the early experiments of gold were made. The very important question now arises, May the effect of an added element mainly depend on its power of forming either a fusible or an infusible compound with the mass in which it is hidden? M. A. Le Chatelier suggests that this is the case, and that the deleterious action of an element is due to its forming a fusible compound with the mass, whilst, on the other hand, the presence of an element which forms an infusible compound with the mass promotes the formation of a fine grain and gives strength. Professor Austen, however, points out that if this should prove to be the case, it would not remove the action of the added element from the operation of the periodic law; for there is much evidence in favor of the view that "the properties of compounds of the elements are a periodic function of their atomic weights." It must be remembered, as against the view of M. Le Chatelier, that the whole tendency of recent work, especially that of Messrs. Heycock and Neville and of the author, is to show that when small quantities of elements are added to a metallic mass, they behave as a gas would and remain free; and the results given in the present Report in the case of bismuth fully confirm this view. It remains to be seen at what point, in the cooling of a highly heated fused mass of a metal forming a solvent, an impurity would enter into combination with a portion of the mass, and what amount of impurity of a given kind has to be present in order that it may lose its individuality. If the fusibility of a free added element were the determining cause of its action, it should be possible to classify the impurities in gold in the order of their fusibility; but any such attempt breaks down hopelessly. To turn to the action of aluminum on gold, if a small quantity of aluminum did enter into combination with a large excess of gold, it may fairly be urged that it would tend to form the very fusible gold-aluminum alloy which contains 10 per cent. of aluminum, and not the singularly infusible one, that which has 22 per cent. On the other hand, the most remarkable case known of the production of a very fine-grained structure, in a mass which, under ordinary conditions, naturally solidifies in large crystalline planes, is presented by the action of a small quantity, ½ to 1 per cent., of tellurium on bismuth; but as 1 per cent. is a large addition, the telluride of bismuth, $Bi\ Te_3$, is probably formed, and it is not readily fusible, for its melting point is at 360 C., or 680 F. With regard to the important molecular change which may take place in a solid metal or alloy, and of which the recalescence of steel is the most striking example, it is no small gain to have ascertained that the temperatures at which such changes occur are altered by pressure; and this seems to be a conclusion at which it is safe to deduce from the result of the experiments given in the present report. The profound change which is produced in the properties of metals by alloying them is well shown by some recent experiments by Professors Dewar and Fleming. They have examined the effect of very low temperatures on the electrical resistance of pure metals and alloys, and the results tend to prove that if pure metals could be reduced to the absolute zero of temperature, they would offer no resistance to the passage of an electric current. This is true of soft, pliable metals like gold, and rigid ones, such as nickel. Impure metals and alloys behave very

differently; the diminution of resistance by exposure to cold is very marked, but the direction of the curves representing resistance and temperature appears to indicate that the resistance at the absolute zero of temperature would still be considerable.

THE JAFFA & JERUSALEM RAILWAY.

A recent consular report by Mr. Selah Merrill, U. S. Consul at Jerusalem, gives the following particulars regarding this interesting railway, the first built in Palestine or Syria, and already described in our columns: The road is 53.6 miles long, with 30 miles located on the plains and the remainder over mountainous country. There are no tunnels, long detours being preferred; but there are four fine iron bridges and at least five deep cuttings. The steepest grade is 2%, or about 104 ft. to the mile. The gage is one metre, or 3.28 ft., and the wooden ties used came from France and cost at Jaffa 80 cts. each. The rails were made in France and Belgium and the five locomotives in use came from the Baldwin Locomotive Works in Philadelphia. The cars were made in France, and have end doors and a central passage, and are divided into compartments by partitions and doors. About 200 tons of Cardiff and Belgian coal are use per day.

There are five stations on the line between Jaffa and Jerusalem, and the 8½ acres of land at the terminal, about one mile outside the latter city, cost $25,000; whereas 30 years ago the same land was sold for $1.00 per acre. This station is 2,476 ft. above the level of the Jaffa station.

The entire road cost about $2,000,000 and was built by a French company organized in 1889. The common labor was performed by Arabs and Egyptians who were paid from 30 to 50 cts. per day. The stonecutters from Bethlehem received from 70 cts. to $1.00 per day; but they are efficient workmen in stone, made so by many generations of training. There is about 10 ins. of stone ballast on the roadbed and a considerable amount of stone retaining wall. The engineer in charge of surveys and construction was Mr. Gerald Eberhard, a Swiss, who was engaged on the Panama railway for about 8 years. The running time between Jaffa and Jerusalem is 1¾ hours down grade and 3½ hours coming up, and the fare is $2.50 first, and $1.00 second-class.

PERSONALS.

Mr. H. D. Bartholomew has been elected City Engineer of Lansing, Mich.

Mr. J. J. O'Neill has been reappointed Township Engineer of East Orange, N. J. This is his third term.

Mr. Ralph Modjeski, civil engineer, Chicago, has removed his office from 218 La Salle St. to the Monadnock Building.

Mr. F. A. Dunham, of Plainfield, N. J., has been re-elected City Engineer of Dunkirk, N. Y., making this his third term.

Mr. McClellan Dodge is City Engineer of Madison, Wis., and not Mr. G. M. Norris, as erroneously stated in our issue of April 27.

Mr. O. R. Rauchfuss, of the firm of Rauchfuss & Zinn, engineers and surveyors, has been appointed City Engineer of Joliet, Ills.

Mr. H. W. Hammond has resigned his position as Superintendent of the Western Division of the New York & New England R. R.

Mr. F. H. Davenport has been appointed City Engineer, and Mr. E. S. Greenleaf, Superintendent of Water Works, at Jacksonville, Ill.

Mr. John C. Chase, M. Am. Soc. C. E., Wilmington, Del., has recently been appointed a member of the North Carolina State Board of Health.

Mr. L. W. Leete, of the firm of Leete & Williams, engineers and surveyors, Huntington, W. Va., has been re-elected City Engineer of Huntington.

Mr. James P. Maxwell, for four years State Engineer of Colorado, has been succeeded by Mr. Chas. B. Cramer, late mineral surveyor at Aspen, Col.

Mr. A. S. Cooper, formerly City Engineer of West Superior, Wis., has been elected Village Engineer of West Duluth, Minn., vice Mr. John Krey, resigned.

Mr. Samuel G. Artingstall has been appointed City Engineer of Chicago, and not Mr. Cooke, as previously stated. Mr. Artingstall has held this position before.

Mr. John S. Titcomb, formerly Deputy State Engineer of Colorado, has opened an office as civil engineer at Denver, Colo. He is Secretary of the American Society of Irrigation Engineers.

Mr. Desmond Fitzgerald, M. Am. Soc. C. E., recently delivered a lecture at Cornell, illustrated by lantern slides, on the construction of dams connected with the Boston water-works.

Mr. Tunis B. Haring, civil engineer and city surveyor, 44 Pine St., New York, has purchased the civil engineering and surveying branch of the business of Maclay & Davies, of which he has had charge for a number of years.

Mr. S. R. Tuggle has been appointed Superintendent of Motive Power of the Newport News & Mississippi Valley Ry. Co. and the Ohio Valley Ry., with headquarters at Paducah, Ky., vice Mr. William Hassman, resigned.

Gen. George S. Greene, past President and honorary member of the American Society of Civil Engineers, and the oldest living graduate of the West Point Military Academy, celebrated his ninety-second birthday on May 6.

Col. G. H. Mendenhall, Lieut. Col. W. H. H. Benyaurd and Major W. H. Heuer, Corps of Engineers, U. S. A., have been appointed by the President Commissioners under the Act of Congress creating the California Debris Commission.

Jacob Humbird, a railway builder, died May 4. He was born in the Ligonier Valley, Pennsylvania, in 1811. He built a section of the Chesapeake & Ohio Canal, and in 1859 he went to Brazil and took a contract for building a government railway.

Dr. Vandenbergh, of the Vandenbergh Laboratory of Chemical Industry, Buffalo, N. Y., has returned from a three-months trip to Venezuela and the island of Trinidad, where he was sent to examine the asphalt deposits in the interests of American capital.

Mr. F. L. Garlinghouse has resigned his position as Chief Engineer of the Pittsburg Bridge Co., and will open an office in Pittsburg, Pa., as consulting and contracting engineer. He has had over 20 years' experience in the design and manufacture of all kinds of structural iron and steel constructions.

Lieut. Robert E. Peary announces that he and his party of ten men will start on their Arctic explorations some time between June 15 and 30. Among the men who will accompany him, according to the same Philadelphia item, are: Dr. F. A. Cook, Edward Astrup and Matthew Henson, who were all members of the late Peary expedition.

Mr. J. S. King, railway contractor, died at East Orange, N. J., on May 2, aged 73 years. Mr. King built part of what is now the New York, New Haven & Hartford R. R., and was also engaged upon the Pennsylvania lines, New York Central, and the Pan Handle routes in western Pennsylvania and eastern Ohio. He is said to have built the first railway bridge across the Ohio below Pittsburg.

Mr. John Fritz, Chief Engineer of the Bethlehem Iron Co., Bethlehem, Pa., has been awarded the Bessemer gold medal by the Iron and Steel Institute of Great Britain. This medal is given by Sir Henry Bessemer for distinguished services to the iron and steel trade, and among others who have received it in the United States are Hon. Abram S. Hewitt and the late Alexander Lyman Holly.

Sir James Anderson, who died in London May 7, was born at Dumfries, Scotland, in 1824. For several years he was Commodore of the Cunard Line. During 1865 and 1866 he was the commander of the steamship "Great Eastern" while the Atlantic cables were being laid. He was an intimate friend and business associate of the late Cyrus W. Field. Sir James was the first man to demonstrate that submarine cables could be recovered and repaired in deep water, and for this achievement he was knighted. He was instrumental in laying cables in all parts of the world, and was a leading director in several companies. He was also the author of "The Value of Submarine Cables in Time of War," "Government Purchase of Submarine Cables," and other works.

NEW PUBLICATIONS.

THE STEAM ENGINE: A Treatise on Steam Engines and Boilers. Comprising the principles and practice of the combustion of fuel, the economical generation of steam, the construction of steam boilers; and the principles, construction and performance of steam engines—stationary, portable, locomotive, and marine—exemplified in engines and boilers of recent date, by Daniel Kinnear Clark, M. Inst. C. E., M. I. M. E., Hon. Mem. Am. Soc. M. E., Author of "Railway Machinery," "A Manual of Rules, Tables and Data for Mechanical Engineers, etc." London: Blackie & Son, Ltd. 2 vols., 8vo; pp. 788 and 768, 1,371 illustrations; xxi. plates; 197 tables ;$12.

The appearance of a voluminous work on the steam engine by the author of "A Manual for Mechanical Engineers" is an addition to the literature of that subject which will be welcomed by American as well as English engineers. The volume before us represents a vast amount of labor in the collection and compilation of data. Not all of it is of practical value at the present day, it is true; but for the most part Mr. Clark has shown in this book the same happy faculty of selection and analysis which made his "Manual" such a boon to engineers; giving just the information which a busy engineer wants, and in a most convenient, compact and readily comprehended form.

The portion of the work which will be of most value to American readers is Vol. I., and especially the first parts of Vol. I., in which the author discusses the principle of steam boilers, heating powers of fuels, contrivances for smoke prevention, systematic trials of furnaces and boilers, etc. This is a field on which investigations have been widely scattered, and authorities which carry weight are not numerous as compared with the field of steam engine design. Such subjects as the temperatures attained in boiler furnaces, the rate of absorption of heat in boilers, the principles of smoke prevention, and gas-fired furnaces and powdered fuel furnaces are discussed at length, and the results given are those found by the most careful and reliable experimenters.

Although it does not fill so great a void as the discussion of the principles of steam boilers, the second section of Vol. I., devoted to the principles of steam engines, will find many interested readers among American engineers, and the same is true of some portions of the third section, devoted to the construction of steam boilers.

Vol. II., on the other hand, contains comparatively little which will be of practical value on this side of the water. Of course the libraries of every engineering society or engineering school should have both volumes of the work; but engineers who buy only such professional books as will be of practical use to them may hardly feel that they get the worth of their money in purchasing Vol. II. They will consult the first volume at a venture, about forty times, where they will consult the second volume once. The first 90 pages of Vol. II. are devoted to an excellent discussion of valves, valve-gears and governors; but the remainder consists of descriptions of stationary engines, pumping engines, locomotives and marine engines, etc., nearly all of which are taken from English or Continental practice. The composition of this volume appears to have been completed by the author some three years ago—a fact which makes little difference with his discussion of foundation principles, but detracts much from the value of his description of existing machines and processes.

For example, the demand for steam power for producing electric current has led to the evolution of new styles of engines and to important advances in practice; yet we look in vain in this book for even a mention of the Willans engine, which is one of the most popular English electric light engines; and all the numerous styles of high-speed American engines for electric service are wholly unrepresented, with the sole exception of the Armington & Sims. Again, in the chapter of 18 pages devoted to governors, the only flywheel governor mentioned is one of the earliest forms, invented in 1872. The wonderful perfection which has been attained by modern forms of flywheel governors in the regulation of engine speeds under variable loads, and which is one of the modern marvels of mechanical engineering, is unmentioned in this book. Again, the chapter on compound locomotives contains no mention of American progress in this direction, and the chapter on pumping engines contains only one example of the horizontal direct-acting engine, which is the prevailing type in American practice. The chapter devoted to examples of marine engine practice, on the other hand, contains valuable matter, including the engines of the "City of Paris" and other recently-built vessels; and, as English practice is so generally taken as a guide in this branch of engineering, these examples are of value. A most commendable feature of the work is the universal rule that every drawing is made to scale, and the scale is named. It is true, the drawings are, as a rule, on a small scale and show not much detail, but what they do show can be measured in feet and inches.

The book is beautifully printed on excellent paper, and it is well and concisely written. Its faults are faults of omission rather than commission; and, as the author does not cumber his pages with far-fetched mathematical discussions, we can forgive him for his neglect to commend or condemn the various features of design in the machines which he illustrates and describes.

STREET IMPROVEMENTS IN THE CITY OF DUNKIRK, N. Y. Report by F. A. Dunham, Engineer in Charge. Plainfield, N. J. Paper; 8vo; pp. 30.

This is a reprint of an official report to the Mayor and Council of Dunkirk, describing the work and giving cost in detail for the years 1891-92. The work done was the laying of brick pavement on concrete and on broken stone foundation, the laying of telford-macadam pavement, and the construction of 7,229 lin. ft. of 10 to 15-in. sewers. The appendix contains the forms used for order to property owners to make gas, sewer and water connections, order for extra work, engineer's monthly estimates, affidavit of contractor, guaranty of brick, etc.

MUNICIPAL IMPROVEMENTS: A Manual of the Methods, Utility and Cost of Public Improvements, for the Municipal Officer. By W. F. Goodhue, C. E. New York: John Wiley & Sons; 12mo; pp. 120; 4 illustrations. Price, $1.50.

If this little book could be put in the hands of all

city, town and village councilmen, and other officers having to do with municipal improvements, our cities and villages would be in much better condition, and the lot of the city engineer, superintendent of streets, sewers, water-works, lighting and street railway plants would be easier and more pleasant. The book is clearly written, and the several sections are brief and to the point.

LOCAL GOVERNMENT BOARD: Report for the Year ending June 30, 1892. Hugh Owen, Secretary; 8vo., pp. clxxx., 611; tables and folding plates. London: Eyre & Spottiswoode, Price 3s 8d.

The 50 pages in this report devoted to the eight Metropolitan water companies which supply London with water, are full of interest. The extent of the works at the close of 1891, their financial and other operations, and the quality of the water, as determined by monthly analyses, are all clearly and concisely set forth. The other parts of the report contain little of engineering interest. A brief note regarding the London water supply was given in our issue of May 4, 1893.

REPORT OF THE RAILROAD COMMISSIONERS OF THE STATE OF NEW HAMPSHIRE for the year 1892. Pub. Doc.; 8vo; cloth; pp. 270; map.

All but 25 pages of the report is taken up with the returns from the various railway companies and the decisions of the commission. There is nothing of technical interest.

PROCEEDINGS OF THE TENTH ANNUAL CONVENTION OF THE ROADMASTERS' ASSOCIATION OF AMERICA. Secy. J. H. K. Burgwin, Grand Rapids, Mich., 8vo.; pp. 121.

This is the full report of the meeting held at Chattanooga, Tenn., and Atlanta, Ga., Nov. 15, 16 and 17, 1892, the proceedings of which were published in our issue of Dec. 1, 1892.

THE UNITED STATES NATIONAL MUSEUM: Report of the Smithsonian Institution for the year ending June 30, 1890. 8vo; pp. xviii., 811; 143 plates and 90 figures in the text.

Over 400 pages of the last report of the National Museum is taken up with papers describing its collections, many of which are profusely illustrated with half-tones. Among these, one relating to the geology of the earth's crust by Mr. Geo. P. Merrill, and another on the "Log of the Savannah," the first steamship to cross the Atlantic, by Mr. J. Elfreth Watkins, Assoc. Am. Soc. C. E., are of greatest engineering interest. A paper on "The Methods of Fire Making" is very interesting, as are others on "The Humming Birds," and "The Catlin Collection of Indian Paintings."

FOURTEENTH ANNUAL REPORT OF THE STANDARD CONSOLIDATED MINING CO. Leo. Von Rosenberg, New York. 4to; pp. 47; maps and illustrations.

This is the company's report for the year ending Feb. 1, 1893. The manager's report shows 16,336 tons mined at an average cost of $6.14 per ton for mining. This ore yielded $17.93 per ton of gold and $1.99 per ton of silver, the cost of milling being $3.52½, or a total of $10.58 per ton of ore produced.

KNOTS, SPLICES, HITCHES, BENDS AND LASHINGS.—Illustrated and described by F. R. Brainard, Ensign, U. S. N. New York: Practical Publishing Co. 16mo; cloth; pp. 76. $1.00.

As we have more than once mentioned, some knowledge of the art of knotting and splicing is often of the greatest value to the civil engineer, and the time is well spent in acquiring it. In the present work, Ensign Brainard tells how the many knots, splices, hitches, etc., are made, and for what purpose they are used. Tables included give the size and strength of hemp and iron and steel wire rope, and the concluding chapter gives the definition of nautical terms used in connection with the handling of ropes.

TRADE PUBILCATIONS.

ELECTRIC MOTORS.—Commercial Electric Co., Indianapolis, Ind., 8vo; pp. 19; illustrated.

The company manufactures motors, dynamos, generators and other electric plant, and makes a specialty of wrought iron field magnets. The company states that the all-forged field magnet construction of its machines is contrary to previous practice in this country, for, though it has been used in some case for street-car motors, also in very small machines, for which drop forgings could be procured, this company claims to be the first to produce a full line of motors and dynamos embodying this construction. In England the great superiority of wrought over cast iron for the purpose named is said to be generally recognized and followed by the leading makers, and the company states that the substitution of wrought for cast iron in field magnet frames represents a substantial advance in the art of dynamo and motor building.

INTERMITTENT FLUSH TANKS.—Flush Tank Co., Chicago. 4to; pp. 32; illustrations.

This pamphlet describes and illustrates the Rhoads-Williams, Field-Waring and Cuntz flush tanks, all the United States patents for which are held by this company. The pamphlet also illustrates and describes an inspection pipe for small sewers, a backwater trap, and the eduction grease trap, with closets and some other fixtures. The pamphlet is admirably gotten up.

PRACTICAL SEWAGE PURIFICATION: With a Description of the Aluminoferric Process Invented and Patented by Peter Spence & Sons, Manchester (England) Alum Works. 8vo; pp. 27; illustrations.

Aluminoferric, according to an analysis given in W. Santo Crimp's "Sewage Disposal Works," consists of 14% of soluble alumina, 0.75% of peroxide of iron, 33.81% of sulphuric acid in combination with the above bases, and 51.44% of water. It is sold in the form of slabs, from which it is dissolved for mixture with sewage. The pamphlet contains some general information on sewage purification aside from that relating to this process.

MINING MACHINERY.—American Enterprise in Mining Machinery; What the Rand Drills are Doing in Africa; Power, Mining and Metallurgical Machinery; Ore-Sampling Machinery. Frazer & Chalmers, Chicago and London. 8vo; pp. 8, 8, 14 and 20; illustrated.

These four pamphlets give particulars of American drills, hoisting plant, gold stamp mills, etc., used in this country and abroad. The firm makes a specialty of all kinds of machinery for mining and metallurgical work, and has the agency for several specialties, including the Shay geared locomotive, the Bridgman ore sampling machine, etc.

HAND TRUCKS.—Boston & Lockport Block Co., Lockport, N. Y. 12mo; pp. 57; illustrated.

This is an illustrated catalogue and price list of all kinds of hand trucks, baggage trucks, etc.; and also skids, wheels, wagon jacks, and the Giant car pusher. The company has facilities for making special trucks of any desired pattern.

BLOCKS.—Boston & Lockport Block Co., Lockport, N. Y. 8vo; pp. 62; illustrated.

This is a new edition of the company's catalogue and price list of blocks for hoisting purposes, including several specialties, such as steel tackle blocks, roller bushings, differential pulley blocks, etc. Special attention is called to the five-roller metalline and phosphor-bronze self-lubricating bushed blocks, as being especially adapted for heavy and rapid hoisting.

STEEL.—Crescent Steel Co., Pittsburg, Pa.; 12mo., pp. 14.

This is a catalogue and price list of the different grades of Crescent steel for tools, drills, drill rods, saw plates, wire, etc.

WATER METERS.—Thomson Meter Co., Brooklyn, N. Y.; 8vo.; pp. 52; illustrated.

This is a very elaborate descriptive catalogue of the Thomson meters, of which 36,000 are said to be in operation in this country, while the plant has been increased to a capacity of 25,000 meters per year. The meter is of the disk type, on the positive displacement principle, registering by the amount and not by the current of water. Meters, dials, taps, strainers, etc., are illustrated.

TOOLS.—Brown & Sharpe Mfg. Co., Providence, R. I.; 16mo.; pp., 306; illustrated.

The Brown & Sharpe machines and tools are too well known to need special mention. This illustrated catalogue and price list includes numerous varieties of milling, tapping, grinding, polishing and other machines; screw machines, lathes, gears and gear cutters; straight edges, gages and calipers, etc., etc. Some additions have been made to the machines regularly manufactured, as mentioned in our column of Industrial Notes.

STEAM GAGES AND VALVES.—Crosby Steam Gage & Valve Co., Boston, Mass. 8vo; pp. 148; illustrated.

This is an illustrated catalogue and price list of gages for various purposes, engine counters, marine and locomotive clocks, pressure recording gages, and gage testers. Chime steam whistles, pop safety valves relief and safety valves, lubricators and indicators are among the other specialties of this company.

SOCIETY PROCEEDINGS.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—At the regular meeting on April 14, Thomas H. Johnson, Vice-President, in the chair, the papers of W. G. Wilkins and G. Kaufman, on "Foundations," read March 21, were discussed. The following is an abstract of Mr. Kaufman's paper:

The chimney in question was damaged by a severe wind storm, and the writer was called upon to report whether it could be repaired and put in absolutely safe condition. The report was adverse to its being repaired, and it was taken down and another built in its place. The stack was square, and built on a brick pedestal. Total height from foundation to top, 137 ft. 6 ins.; top of pedestal to top of stack, 125 ft. 6 ins. Shaft, 10 ft. square on bottom and 6 ft. 6 ins. square on top.

The soil on which the stack was built consisted of sand and blue clay, in which was interspersed fine gravel. The foundation consisted of a bed of concrete 30 ins. thick, having imbedded therein two layers of 5-in. I-beams weighing 10 lbs. per ft., placed 3 ft. apart. On top of the concrete were three courses of cut stone. The foundation was stepped off on three sides; one side of the stack (southern) being placed in the same vertical plane as the southern edge of the foundation courses. This caused eccentric loading of the foundation, and was done for purpose of saving room. An arched opening, 2 ft. 2 ins. wide and 5 ft. high, was left at the bottom of the stack for cleaning purposes, on the east side; and on the north side, 14 ft. up, was another, 4 ft. 6 ins. wide and 5 ft. 2 ins. high, to admit the flues. The shaft was lined with fire brick, separated from the shaft proper by an air space. Hard burned brick, laid in cement, was used for the outer shaft.

During building, some cracks appeared about the flue opening, and a 2-in. tie-rod was there inserted. When the stack was about done, a brisk windstorm from the south badly shattered the bricks in the north face above and below the flue opening, and to some extent those on the east and west faces. The arch in north face bulged outward, causing fear that the stack would collapse through weakness at that point. Immediate danger was removed by tying the east and west faces together at that place. The plans were revised in accordance with the principles set forth by Professors Rankine and Bancroft. In the paper, the set of rules adopted by the Metropolitan Board of Works, of London, governing the construction of tall chimneys was given.

By the calculations it was found that: 1, Under a wind pressure of 50 lbs. per sq. ft. the pressure on the southern edge was 5.7 tons per sq. ft., entirely too high for the soil; 2, At a section 77 ft. up, the stack would barely stand a pressure of 40 lbs. per sq. ft.; 3, At the springing line of the arch of the flue opening, the maximum safe wind pressure was 30 lbs. per sq. ft.; 4, The base should have been 12 ft. 6 ins. square instead of 10 ft., and the load on the foundation should have been placed concentrically; 5, Instead of 25 ins., the lowest section should have been 31 ins. thick. For these reasons, and because the bond of the brickwork was destroyed, and furthermore because the firebrick lining had been tied at short intervals by means of ¼-in. plates to the outside brickwork, causing great doubt as to the stack in its shattered condition being able to withstand the strains due to the unequal expansion of firebrick and ordinary brick, a report was rendered advising that it be taken down.

Mr. G. S. Davison read a paper on "The Water Supply of the Oliver Coke Works."

The Chemical Section met April 25, Mr. Fred Crabtree in the chair, and 35 members and others were present. A report of progress was made by Prof. F. C. Phillips for the Committee on Water Supply, appointed at the February meeting. Professor Phillips read a paper on "Experiments with the Anderson Purification Process on Allegheny City Water." The experiments had been successful. The percentage of organic matter had been materially reduced, and all mud removed. The process had produced 480 gallons of clarified water per square foot of filtering surface per 24 hours (50 gallons in 24 hours being the average rate in sand filtration). The process, as used in Antwerp, costs about $1 per 1,000,000 gallons. Estimates for this country are higher. Very little of the sediment passes out of the settling reservoirs, which are placed between the purifiers and the filters. Filtration will eventually be dispensed with as a part of the process. Punchings of wrought iron or steel are best suited to the process.

Mr. James O. Handy showed, by calculations, that only a very small percentage of the organic matter in the Allegheny River water at Pittsburg could be of sewage origin. The remainder must come from peat, dead leaves, etc. The water is therefore of great organic purity, but as it receives sewage constantly at various points above Pittsburg it may at any time bring disease germs. He also gave results of the use of water. The cities using sand filters have a very low death rate from typhoid fever. London has been a notable example. Sand filters also remove cholera germs almost completely, as experience at Altoona has shown.

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting on April 15, Mr. James Christie, Vice-President, in the chair, and 34 members and visitors present, the following communications were presented by the secretary: A letter from the president, written from Pueblo, Mexico, on April 4, stating that he had been collecting information on engineering work in Mexico, which he hoped to present to the club upon his return. A circular letter from the Committee of Fifty for a New Philadelphia, requesting the appointment of three delegates to represent the club in the union committee to procure an authoritative expression of public opinion with regard to water supply, street cleaning, etc. A letter from Mr. Max E. Schmidt, secretary of the General Committee of Engineering Societies, requesting the loan for the six months of the World's Columbian Exposition of suitable photographs to be hung on the walls of the Engineering Headquarters in Chicago, and in the Mines and Mining Building at the Exposition, the same to be forwarded at the expense and risk of the sender, on or after May 1, by express, and addressed to 10 Van Buren St., Chicago.

Mr. Edward K. Landis read a paper on "The Development of the Tilly Foster Iron Mine," in which he gave a brief historical account of the possession

and early working of the property, and a detailed description of its more recent development. It is situated in Putnam county, New York state, about two miles west of Brewster, and 52 miles north of New York city. The ore bed is about 600 ft. deep by 100 ft. wide and 500 ft. long. The machinery and methods employed in digging the ore, supporting the mine by piers and arches, and conveying the material from the mine to the surface were described in detail, and reasons were given for the failure of the expensive system of arching employed. The processes and parts of the mine were illustrated by lantern slides from photographs taken by the author. In answer to questions, Mr. Landis stated that he did not remember how much the rock cost per cubic yard, but that the figures could be found in a paper by Mr. McDowell, in the "Proceedings of the American Institute of Mining Engineers." No general figures could be given for the percentages of ore and rock, as they varied very much, sometimes running lean ore for a considerable extent, and then varied, perhaps, by a pocket of rock, which had to be cut through. The ore vein is roughly a lens, slanting at about 66° to the horizontal.

The following from Mr. Perre Giron was presented in answer to the discussion on this paper read at the last meeting: "Mr. R. W. Lesley stated that in every case where briquettes have been kept of the cement burned in the rotary kiln he has found them to disintegrate, and dust away at periods of one year and over. This statement is in contradiction of facts that Mr. Lesley knows very well that, for the last three years a considerable amount of Portland cement, burned in rotary kilns, has been in use in this country, and, to name only one instance, the new Reading Terminal, in Philadelphia, has been built mostly with such cement. The writer possesses some briquettes of cement made in the first rotary kiln built by Mr. Ransom, in England, almost ten years ago, and these briquettes are very well preserved. Besides, the permanence of cement can be readily and quickly ascertained by the present methods of testing, without waiting for the action of time. With regard to the cost of fuel in the rotary kiln, Mr. Lesley states again that the oil necessary to burn a ton of cement would cost $1.80, while the cost with coke would be $1.20. The figures given in my paper establish, on the contrary, that the expense of oil per ton of cement does not exceed $1.32, just as stated by Mr. Thomas D. Whitaker, and, in fact, it is generally less."

The secretary stated that illness had prevented Mr. Giron from presenting his paper on the "Grinding of Portland Cement," but that it would be ready for the next meeting. L. F. Rondinella, Secy.

ENGINEERING ASSOCIATION OF THE SOUTH.—The regular monthly meeting was held at Nashville, Tenn., April 13, 1893, with a good attendance, Vice-President Wm. T. Magruder presiding. The feature of the evening was a discussion on "High Duty Attachments for Non-Rotative Pumping Engines," led by Mr. L. d'Auria. He showed that, apart from any consideration relating to expansion, the aggregate weight of the reciprocating parts in the Cornish engine is 2.3 times the load, in the Bull engine equal to the load, and in the Worthington one-tenth the load, though it could be made heavier without restriction; but, with the reduction of weight in these three successive types of engines, the rate of steam expansion had also to be reduced, it being possible in the Cornish engine to use four expansions, in the Bull but two, while in the Worthington simple cylinder expansion was practically impossible.

The piston speed is effected by what he calls "effective weight," this weight being expressed by the sum of the products of each of the reciprocating parts by the square of the velocity of its center of gravity or gyration, expressed in terms of the velocity of the plunger as a unit. In using steam expansively, this force in the first part of the stroke is greater than the load and will perform an excess of work, "accelerative work." According to a law discovered by Mr. d'Auria, the mean speed of the plunger during the stroke in a non-rotative pumping engine equals

$$C\sqrt{\frac{\text{accelerative work}}{\text{effective weight}}}$$

the coefficient, C, varying with the variation of the propelling force, and, in the average, equaling about 4.8. By the application of this law it was proved that the Bull engine could have been made lighter and yet used a higher rate of expansion than the Cornish, and that a Worthington engine could be transformed into a high-duty engine by adding a reciprocating weight, about 7 or 8% of the load and moving with a velocity four times as great as that of the plunger. This added reciprocating weight, which constitutes the d'Auria high-duty attachment, was shown in the form of a liquid column, thus: A direct-acting plunger is attached to an extension of the piston rod of the pumping engine and moves in a cylinder of its own; at the ends of this cylinder the ends of a U-shaped pipe are attached and the cylinder and pipe are filled with a liquid. The area of the pipe being less than that of the plunger, the velocity of the liquid column is proportionally greater than that of the piston. Shocks due to excess of energy at the end of the stroke are prevented by passing the liquid around the plunger through small channels uncovered when the plunger, by this excessive pressure, passes beyond its usual stroke. This feature, as well as the verification of the law of piston speed, Mr. d'Auria showed by a model in which the propelling force was a spring attached to one end of the plunger rod, the load being represented by a weight pulling at the other; these balanced only at the middle of the stroke, at the beginning the pull of the spring was about twice that of the weight, and at the end only equaled the friction of the working parts. When the apparatus was filled with liquid, the piston made a steadier, longer stroke than when no liquid was used, showing the friction of the liquid to be insignificant. Diameter of the plunger, 3.94 in.; diameter of pipe, 2.06 in.; ratio of their areas, 3.65; weight of their moving parts, 61 lbs.; weight of water in the pipe, 51.5 lbs.; hence the effective weight with the water is $W = 61 + 51.5 \times \overline{3.65}^2 = 747$ lbs. and without the water is only $W = 61$ lbs. The accelerative work in both cases is $Q = 4.85$ ft.-lbs., length of stroke, 0.46 ft. The velocity was found to be with the water 0.383 ft. per second, and without the water, 1.33 ft. per second. According to Mr. d'Auria's approximate formula,

$$V = 4.8\sqrt{\frac{Q}{W}},$$

the velocities equal 0.384 and 1.34 ft. per second, respectively, showing close agreement with experiment. Besides, the figures show that the effect of the water in the pipe was to reduce the piston speed to about one-third that without water, and this without appreciable loss by friction

The next meeting will be held at Nashville, Tenn., May 11. Walter G. Kirkpatrick, Secy.

ENGINEERS' CLUB OF CINCINNATI.—At the last regular meeting, Mr. E. F. Layman read a paper on "Sidewalk Improvements in the Vicinity of Cincinnati," which comprised a review of the legislation enacted by the state of Ohio in the last few years pertaining to the construction of and manner of payment for sidewalk improvements, and a description of the proper construction, workmanship and materials necessary to secure the best results in building artificial stone sidewalks, which have been very generally adopted in the suburbs—an expenditure of $400,000 having been made on them in a few years. J. F. Wilson, Secy.

BOSTON SOCIETY OF CIVIL ENGINEERS.—The regular monthly meeting was held April 19. John R Freeman, president, in the chair, and over 100 members and visitors present. An interesting address was made by George S. Morison, of Chicago, on "Bridging Western Rivers," in which he described some of the difficulties experienced in securing foundations for bridges in the Ohio, Missouri and Mississippi rivers, and spoke of the peculiar characteristics of each. He also gave a full description of one of the latest bridges built by him—that across the Mississippi River at Memphis, Tenn. S. E. Tinkham, Secy.

INSTITUTION OF MECHANICAL ENGINEERS (From our London Correspondent).—Three papers were down for reading at the meeting held April 20 and 21, under the presidency of Dr. Anderson, but the time at disposal only permitted of two being considered. The first, by Prof. W. C. Roberts-Austen, was entitled "Second Report to the Alloys Research Committee." The object of the investigations dealt with (form a continuation of previous work treated in the first report, given in the proceedings of the Institution for 1891, p. 543) was to extend a research previously made by the author upon the application of the "periodic law" of Newlands and Mendeleeff to the mechanical properties of metals, and an abstract of this is given in another column.

The second paper, by Mr. Wm. Dean, Locomotive Superintendent of the Great Western Ry., dealt with "Tensile Tests and Chemical Analyses of Copper Plates from Fireboxes of Locomotives on the Great Western Railway." The author said that, as considerable differences had been experienced in the durability of copper fireboxes in locomotives on that railway, and which could not be accounted for by differences in the conditions of working, it was decided to commence testing and analysing samples of copper from fireboxes which had run long mileages, and from others which had run short mileages only. Down to March of the present year 18 samples had been selected and tested. The test pieces were sheared out of the plate, straightened by hammering cold, and planed so as to have a uniform sectional area of half a square inch throughout the length tested of eight inches. The testing machine used for the tensile test was a compound lever horizontal machine of Tangye's pattern, with hydraulic cylinder, and in making the tests the pressure was applied by hand pumps. As the number of samples examined was comparatively small, and the results wanting in uniformity, Mr. Dean considers, as was said at the meeting, that it would probably be unsafe to form from those tests any decided conclusion as to the best composition for copper fire-box plates. It would appear, however, that the presence of a small percentage of arsenic was in no way detrimental to the lasting quality of the plates.

The third paper, the reading of which was postponed, was by the Research Committee on Marine Engine Trials, entitled "Abstract of Result of Experiments on Six Steamers, and Conclusions Drawn Therefrom in Regard to the Efficiency of Marine Boilers and Engines."

CENTRAL RAILWAY CLUB.—At the meeting on April 28 amendments to the Interchange Rules were discussed. The most important changes recommended were with reference to drawbar repairs, that any properly fitted link-and-pin drawbar should be accepted in place of a broken link-and-pin drawbar, but that all broken M. C. B. couplers must be replaced with M. C. B. couplers; and the uncoupling gear must be made operative. The question was discussed where the handholds required by law to be placed on the ends of cars should be located, and it was arranged to get the opinion of the American Railway Association and Interstate Commerce Commission on the subject.

NEW ENGLAND RAILROAD CLUB.—At the regular meeting to be held at the United States Hotel, Boston, May 10, at 7:30 p. m., the subject for discussion was "The Desirability of Having Standard Trucks and Foundation Brake Rigging for Freight Cars, and the Influence This would have on Repairs." Francis M. Curtis, Secy.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—At the meeting in the Society's rooms, in Montreal, on May 4, a paper on the "Quebec Land Slide of 1889" was read by Mr. Chas. Baillairge, and the discussion on Mr. J. S. Armstrong's paper on "Transition Curves" was resumed. C. H.McLeod, Secy.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.—At the meeting on May 1 Mr. E. E. Woodman addressed the society on the geology of the Lake Superior iron regions. The society then adjourned to Oct. 2, 1893. C. L. Annan, Secy.

MONTANA SOCIETY OF CIVIL ENGINEERS.—At the regular monthly meeting on May 13, at the office of Sizer & Keerl, Mr. O. C. Dallas will read a paper on "Method of Acquiring Title to Mineral Lands." G. O. Foss, Secy.

COMING TECHNICAL MEETINGS.

COLUMBIAN ENGINEERING SOCIETY.
May 16. Secy., F. W. Hart, Washington, D. C.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
May 16. Secy., R. H. Clark, Pittsburg.
WESTERN RAILWAY CLUB.
May 16. Secy., C. F. Street, Rookery Building, Chicago.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
May 17. Secy., L. V. Carmalt, Roanoke, Va.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
May 17. Secy., F. Collingwood, 127 East 23d St., New York.
BOSTON SOCIETY OF CIVIL ENGINEERS.
May 17. Secy., S. E. Tinkham, 36 Broomfield St.
ENGINEERS' CLUB OF ST. LOUIS.
May 17. Secy., Arthur Thacher, Odd Fellows' Building.
ENGINEERS' CLUB OF CINCINNATI.
May 18. Secy., J. F. Wilson, 24 W. 4th St.
NEW YORK RAILROAD CLUB.
May 18. Secy., H. G. Prout, 73 Broadway, N. Y.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO
May 18. Secy., C. F. Franson, Portland Block.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
May 19. 901 Washington Building.
ENGINEERS' CLUB OF PHILADELPHIA.
May 20. 1122 Girard St. Secy., L. F. Rondinella.
SWEDISH ENGINEERS' CLUB.
May 20. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.
DENVER SOCIETY OF CIVIL ENGINEERS.
May 23. Secy., F. E. King, Jacobson Block.
CENTRAL RAILWAY CLUB.
May 24. Secy., S. W. Spear, Buffalo, N. Y.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
May 26. Secy., C. H. McLeod, Montreal, P. Q.
ENGINEERS' CLUB OF MINNEAPOLIS.
June 1. Secy., E. Nexsen, 504 Kasota Block.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
June 2. Secy., F. K. Smoot, 308 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
June 2. Secy., O. Von Geldern, 719 Market St., San Francisco.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
June 5. Secy., C. L. Annan, City Engineer's Office.
WESTERN SOCIETY OF ENGINEERS.
June 7. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
June 8. Secy., F. W. Mowbray, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTH.
June 8. Secy., W. G. Kirkpatrick, Nashville, Tenn.
MONTANA SOCIETY OF CIVIL ENGINEERS.
June 10. Secy., G. O. Foss, Helena.
ENGINEERS' CLUB OF KANSAS CITY.
June 12. Secy., Waterman Stone, Baird Building.
WISCONSIN POLYTECHNIC SOCIETY.
June 12. Secy., M. F. Schinke, City Hall.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
June 13. Secy., Parker N. Black, Capitol Block, Atlanta, Ga.
CIVIL ENGINEERS' CLUB OF CLEVELAND
June 13. Secy., F. C. Osborn, Case Library Bldg.
NORTHWEST RAILROAD CLUB.
June 13. Ryan Hotel, St. Paul Secy., W. D. Crosman.
NORTHWESTERN SOCIETY OF ENGINEERS.
June 13. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
June 14. Wichita, Kan
NEW ENGLAND RAILROAD CLUB.
June 14. Secy., F. M. Curtis, C. C. R. R., Boston.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
June 16. Secy., D. W. Meeker, St. Paul.
AMERICAN RAILWAY MASTER MECHANICS ASSOCN
June 19. Lakewood, N. Y. Secy., Angus Sinclair, New York
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Sept. 5. Secy., W. Halliburton.

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The Manhattan Railway Co., after a long delay, has rejected the plans of the New York Rapid Transit Commission, as submitted by the latter, for the extension of the existing elevated railway system, and offers terms of its own. These terms practically demand the withdrawal, or the material modification, of the vital points in the proposition of the commission; in other words, the answer means an indefinite delay for rapid transit in any form, and probably an entirely new deal on radically different lines. The company says the extension of its lines, as planned by the commission, would cost $22,694,976, and gives its figures in detail with a liberal allowance for all contingencies, except the important one of damages to abutting property. The company declines to pay for this franchise the proposed tax of 5% on its net receipts, less ordinary taxes and operating expenses, and gives as one reason for this refusal that "it is obvious that the receipts from lines now in operation can have no relation to the value of these new franchises." The company also objects to paying for the additional third tracks laid down, as it expects little direct profit from the long haul implied by this further service. The Manhattan Ry. Co. is ready to accept the scheme adopted by the commission and to undertake to build the road and the improvements contemplated upon the following conditions: It will pay to the city of New York the same compensation fixed for the New York lines under the act of 1868, viz., 5% upon the net income from passenger traffic on the new lines of railway, other than the third tracks.

The difference between the proposition of the railway company and that of the rapid transit commission is so radical that it may be said in advance that the time spent in discussing it is wasted. It is quite evident that the Manhattan Ry. Co. is just now content to leave well enough alone and does not care to attempt the raising of the very large sum required by the contemplated improvement, in the face of present unsettled financial conditions. The company has all the advantage of position and can well afford to wait; it has all the traffic it can handle, and more too, and sees no immediate profit in the proposed extension. There is some reason, too, in its objections to the terms imposed by the commission. The Rapid Transit Commission was especially created to provide a means of rapidly traveling from one end of Manhattan Island to the other; and this means a long haul for a single fare and is just the kind of traffic that pays least for the expense involved. It is not the class of travel that the Manhattan Co. wants, nor is it disposed to pay roundly for this privilege. The commission had better retrace its steps and honestly consider some method of transit entirely independant of existing lines; a system carried out more in accordance with the requirements of solidity of structure, speed and safety to passengers, than can be afforded by any compromise with elevated roads built to meet demands which they have already far outgrown. Previous attempts of the commission in this direction have by no means exhausted the possibilities of the case, either in route or in the class of structure proposed; and a little more common sense and fairness and less politics in the schemes for disposing of the rights to construct and operate the system proposed would doubtless lead to more satisfactory results in that line than any yet recorded. The New York Rapid Transit Commission has a difficult task to perform, but it has not so far covered itself with glory in its attempts to solve the problem before it.

The state ownership of railways, has been on trial in Europe for about 50 years. In 1849 the Prussian government commenced the building of a line from Berlin to its eastern boundary, but the results were generally unfavorable and the ownership by the state would probably have been abandoned had not the military experience of the wars of 1866 and the Franco-Prussian war shown the defects of these existing conditions and the strategic advantages of a well devised and operated system of railways. Under the new empire the commencement was made in extending and unifying means of communication, and in 1879 a bill was passed providing for the purchase by the state of all railways in private hands. From that time forward these roads were gradually acquired, until the government now owns 15,530 miles out of the total 16,775 miles of railways in Prussia. In this state the general management of these roads has been at least financially successful; and according to recent information the revenue derived from them not only pays the interest on the railway debt, but also on the entire state debt; and for the fiscal year ending March 31, 1890, there was a surplus of over $38,000,000 derived from this source. This was the maximum surplus, it is true, but for the year 1891-92 it was still about $22,500,000. In addition to this successful operation nearly $160,000,000 of the original railway debt has been extinguished. But, while this is a very favorable showing for Prussia other European states have not fared so well. France, previous to 1842, had a few minor railways; but by the law of June 11, 1842, it was proposed to establish a vast network of lines under the following conditions: The state was to be responsible for the building of the roadbed, the structures necessary and one-third of the land required for the right-of-way, and the departments and communes were to provide the rest of the land. The rails, ballast and material required to operate the roads were to be provided by the companies to whom the operation of the lines was to be leased. While this law has been modified by others passed since 1845, and private companies can now build and operate railways under restrictions imposed by the state, the French government may still be said to control the railways in that country by a system of subsidies, and in the period 1884-90 it paid out about $74,000,000 for the privilege. At the end of 1883 the claims of the state against the railway companies amounted to over $134,000,000. In other words state ownership has been far from profitable under the system of subsidizing corporations practiced in France.

Austrian state railways pay at the most 2¼%; and Hungarian roads pay about 3%. Italian state railways are in a still worse plight, for they paid only 1.63% in 1892, on an investment of about $900,000,000; and the tendency is toward still lower dividends under state management. In 1860, says the "Nuova Antalogia," with a capital account of $109,200,000 the profits were about 3.6%; but with a steady and rapid increase in the total amount invested the profits have as steadily diminished to the figures first given for 1892. A particularly bad omen for the future is the fact that in the same period, 1860-1892, the operating expenses have increased from 53 to 70.4% of the gross earnings. Prussia alone seems to have made her state-owned railways profitable. But Prussia built up her present railway system for strategic purposes mainly, and according to all accounts the administrative organization is defective and far from popular. The primary object of location, equipment and control is to meet the emergencies of war rather than to serve the conveniences of the people in time of peace; and that the system does pay such handsome returns as are credited to it can only be explained by the needs of a dense population, accustomed to military rules and regulations and more prone to travel from place to place than are the people of France or Italy. In Italy particularly the cost of construction has been enormous, and the line along the coast of the Mediterranean, from the French frontier to the coast opposite Pisa and Florence, is almost one continuous line of tunnels. While the Prussian railways are excellently built and equipped, after European standards, they have probably cost less per mile than those of Italy, Austria or Hungary, owing to advantages of natural conformation. France subsidizes her railways purely for military purposes; and apparently is content to pay well for the possible advantages this control may some time return in an emergency. She takes no part in the operation and administration of the lines except in that which pertains to the maintenance of lines useful in war, and in the general control of the accounts and records.

The question of our future timber supply and the annual waste from fire is discussed in a special circular sent out to the lumbermen of the United States by Mr. Fernow, Chief of the Forestry Division of the Uuited States Department of Agriculture. As to the demand for timber, Mr. Fernow figures from the census and other returns that we annually use over 22,000 million cu. ft. of wood, or about 350 cu. ft. per capita. Of this enormous amount over 4,000 million cu. ft. of the best material is converted into lumber; railroad construction consumes about 5,000 million cu. ft. and fencing takes about the same; but by far the larger consumption is for firewood. An uncertain amount is burned every year by forest fires which rage in the western mountains especially, and the total of wood annually disposed of in some way is probably near 25,000 million cu. ft. The area of the United States covered with wood growth is less than 500 million acres, and for the last three decades an increase of about 30% in consumption is indicated for each decade. With this showing, as nearly accurate as the available statistics can make it, it is well to estimate how long this supply will meet an ever increasing demand. From the careful records of the German government and those of private forests in Europe it is known that the average annual growth of wood per acre does not exceed 55 cu. ft., and this includes branches and smaller dimensions down to 3 ins. diameter, wood which is not used in this country. If we confine ourselves to the production of sizes of timber utilized by our wood cutters, says Mr. Fernow, our timber at the age of 125 years would not average in growth more than 35 cu. ft. per year, so that our present acreage, even if well stocked and well guarded and managed would not produce our present annual consumption. And as to our total supply, the most extravagant assumption that can be made, even for the enormous Pacific Coast forests, is an average of 10,000 ft. B. M. now standing on every acre of our wooded territory. With this assumption our standing timber would be exhausted in not much over 100 years, or the time it takes to produce a good-sized sawlog. Most of the timber we are now cutting is over 200 years old, and for some timbers the end is even now relatively in sight. This is the case for white pine, walnut, yellow poplar and ash.

The remedies suggested are the more careful and thorough utilization of our timber products and especially the prevention of unnecessary waste. The most harmful among the latter are forest fires, which not only destroy or deteriorate in value enormous quantities of timber annually, but also render the soil barren by burning up the leaf mold and seedlings and replace valuable timber by scrub and inferior vegetation. The circular presents a draft of a bill for the protection of forest property framed mainly upon that enacted in Maine in 1891 and there successfully applied. This bill can be modified to suit the prevailing conditions in

separate states; but its general purpose is to provide well organized machinery and paid officials to enforce its requirements; to clearly fix responsibility for the execution of the law and to give the officer full power to prosecute offenders. It is assumed that the recognition of a common interest in the protection of property can only be established by making the community and all its members financially liable for any damage. The law creates a forest commissioner, who has general control; constitutes town officers as fire wardens; provides for the employment of fire patrols during dangerous seasons; creates a fire indemnity fund, to be paid to the state by each county for every acre burned over each year, and fixes the liabilities of railway companies, compelling them to keep their right-of-way clean, use spark arresters, etc. The one other practicable and desirable step toward an improvement on existing conditions, suggested by the Department of Agriculture, is a change in the methods of disposing of public timber lands. The present laws invite fraud, trespass, destruction by fire, etc., and they have been denounced as unsatisfactory by every administration for the last thirty years, but without avail. Under the law of March 3, 1891, giving power to the President to reserve timber lands for forest purposes, a beginning has been made, and 13,000,000 acres out of the 60,000,000 or 70,000,000 acres of public timber lands have been so far reserved. Mr. Fernow recommends that this policy be extended to the withdrawal of all public timber land from sale or entry, and to substitute disposal by stumpage under licenses which provide a rational method of protection. The necessity of some immediate and radical change of policy in our treatment of the timber question must be evident to every one, and lumbermen and their associations are especially interested and should do all in their power to hasten legislation tending to prevent waste, promote the growth and to otherwise protect an industry which has an enormous pecuniary and economical value.

THE IDEAL ENGINEERING SCHOOL.

III.

Whether or not the future ideal engineering school will do anything more than is now done to imitate military schools, and depart from the precedents of the older civil professional schools, by giving its students an incidental training in what we may call the manly and social accomplishments, is a large question which would lead us quite too far afield to consider in any detail. The theory on which the civil schools and colleges act has much strength, that that is a thing which every man and every man's parents have had the strongest inducements to look after for themselves, that they have no machinery nor authority nor means for any such use, and that any way the man's character is essentially formed in this respect before he comes to them, and the purpose of the school is only to give knowledge, not to teach manners.

It is a fact, however, that the military academy does take some quite unpromising material and practically make it over during a four-years course, so that there is practically no discernible difference in this respect, and it is a fact also that this is accomplished without any abridgment of scholastic work, but rather the contrary. The government has a special motive for doing this—that it is to be represented by those whom it educates and does not wish to be discredited by them; but it also has a general motive which is common to military and all other schools. The primary aim of every professional school is to train men to SUCCEED in that profession, and to dwell most on those things most needful to success. It has no other purpose or function as such; and in the military profession, where men must pull together in the same harness in intimate relations of subordination and command, and must do so without creating friction or personal antagonism, uncouth or objectionable personal qualities become a burden and obstruction to the sufferer, and the reverse of this his greatest aid, in a sense and to a degree which does not obtain in the three learned professions where abnormal development of knowledge in a particular line is the first and almost the only essential to success. Naturally in these schools nothing but intellectual development is given any thought.

Is it or is it not true that there is the same contrast of conditions, the same intimate and continuous dependence upon the good-will of others whom the engineer has to command or obey, in the engineering profession? If yes, is it or is it not likely that the future ideal engineering school will differentiate itself somewhat from the "learned" professional schools by paying more attention to these matters, instead of paying distinctly less attention to them, as most of them do now?

There is another sharp distinction between military and civil schools which we cannot pass in silence—the distinction between the military and civil schools in inculcating the habits and instinct of truthfulness and personal honor, which every good military school cultivates by every possible device with assiduity and success. While it cannot make a silk purse of every sow's ear, it can and it does leave a stamp upon the character of its men which is never wholly erased, and which surely makes them better officers and better men, and greatly promotes their future success.

It has been well said that the root of every strong instinct or passion of our nature, like patriotism, mother love, and the Wall St. man's respect for verbal bargains, lies not where it seems to lie, in our goodness and in our sense of right, but in necessity. Society cannot get along without it, and those who have it not die out. This, and this only, is the reason for this distinction between the military and civil schools. In any interdependent profession where men are closely thrown together, life becomes intolerable and successful professional work impossible without the mutual respect and confidence which can only come with upright and truthful habits. The same necessity notoriously does not exist in the learned professions; but is it not so in engineering? Is it not so in the higher walks of business life, both as a recognized need and as a fact?

If so, the laxity of our civil schools, and especially of engineering schools, in this respect is very unfortunate and likely to be amended. And it runs through nearly all the schools, from the highest to the lowest, and for it the professors and teachers are alone responsible, for the impressible mind of youth is easily influenced in such matters for good or bad, and it is only necessary to create a strong prepondering sentiment (or prejudice rather) and all will follow it. The present writer remembers with mingled wonder and disgust the extremely low moral tone in such matters which prevailed in the Boston Public Latin School, the oldest school in this country, and perhaps the most famous one, in the early sixties. Surely no school exists with better record, and it was headed by a still famous master of noble and lovable qualities. But the whole spirit and practice of the school was: "Get knowledge, get knowledge; if you can't get knowledge, lie about it and get marks; if you can't get marks, steal them and get standing." Probably most of these youths, after they had escaped from educationory influences and came out into the wicked world, shook off the influence of these practices and became sons of their fathers once more; but if it did not turn some men with good stuff in them into life-long blackguards, it was not the fault of the methods of education. Wether or not they are the same to-day, the present writer has no means of knowing; otherwise he would have hesitated to refer to the school by name. "Tis thirty years since," and more. If he were going to bet, he would bet that they were still much the same, for he has reason to know that essentially similar ideas of the comparative importance of marks and truth are the rule, and not the exception, in all our civil schools, from high to low, and always solely by fault of the instructors or methods of instruction, or both. The only exceptions to this rule which are within his personal knowledge he gladly mentions. He believes that such practices do not prevail in the universities of Virginia under semi-military influences. If that be a necessity to this end, may they always be so.

Is there, or is there not, a subtle connection between these facts and the fact that our civil instructors of to-day have all been trained in colleges where methods of instruction are still modeled on the traditions of the recent past, when their only reason for existence was to train men for the three learned professions—success in which depends primarily on knowing things and being able to talk about them, not in telling the truth about them? Be this as it may, this is the sequence of fact if it be not that of effect.

It must be understood that we are not discussing this question on moral grounds at all. We do not object to lying and cheating because it is wrong and on general principles; but because it is inexpedient and injurious to the students' future prospects and with special reference to engineering as an associative and interdependent profession analogous in that and many other respects to the military profession, and as such needing a specialized training. Neither do we charge (though we suspect it to be true) that the positive influences of any engineering school are injurious in the respects noted. We only charge that they are either negative or nothing; that there is no positive influence exerted nor sensible effort to exert any, when there might be. The graduate may not come out any worse or weaker than when he went in, but he comes out no better or stronger, when he might do so, and with positive benefit to his scholastic acquirements.

If we were called upon to state, in the order of their true importance, the acquirements which an aspirant for success in engineering should have already made at the usual age for graduation—and we now feel called upon to do so—we should place them thus:

1. A good common school (if possible) or high school education.

2. An inward necessity to be able to look himself at all times in the face and be not ashamed, whether for pecuniary faults, or back-biting or unworthy professional emulation.

3. A certain practical gumption and physical vigor and training; an ability to put himself in unpleasant places calmly and to look about him and recognize what he sees for what it is.

4. The ability to appear at his best, and to be both outwardly and inwardly unembarrassed, wherever he finds himself.

5. Book knowledge of engineering, such as is given in engineering schools.

6. The knowledge of the practice of engineering which is now given in the average of good engineering schools.

The last he can acquire in a few weeks in any special line which concerns him. Of all the others, early deficiency of book learning is the easiest to supply, to the extent required for notable success in engineering, because there is this compensating advantage for so great a loss. Whatever the student gets by individual effort, though it may come hard and slow, yet he gets it "solid." The deficiency in quantity is in no small degree made good by the quality of his acquirements thus gained; and as the quantity of abstract knowledge required for the highest grade of success in any particular line of engineering is really quite small—not beyond the reasonable powers of a man with a fair start otherwise to acquire as he needs it—there will always be a large percentage of self-made men in engineering; and if not many such will hereafter rise to the very top, they are even less likely to be found at the very bottom.

We have no doubt that a majority of practicing engineers will fully agree with the substance of the above summary.

THE NEW YORK CENTRAL AIR-BRAKE TESTS.

In our issue of Feb. 23 we published a report of the results obtained in the air-brake tests made at Karner, on the New York Central & Hudson River R. R., last September. This report, while not complete in every respect, covered the most important results of the tests, and some of the lessons to be derived therefrom were summarized editorially in that and the following issues.

The official report of Mr. P. H. Dudley, M. Inst. M. E., the expert who conducted the tests, has just been issued, and any of our readers who desire to study the record of the tests in detail can obtain a copy by application to Mr. J. M. Toucey, General Manager of the New York Central & Hudson River R. R. The complete report is a quarto of over 40 pages, and is accompanied by a set of the diagrams which were taken during the tests by electric automatic recording apparatus. It gives with commendable fullness the results obtained in the tests; but not always in such a form that comparison between the two brakes tested (the Westinghouse and New York) can be readily made.

To abstract the report in detail would be for the most part merely a repetition of the article

published in our issue of Feb. 23, and we will therefore refer our readers to that article and to the official report, and discuss at present merely the broad question of greatest practical importance at the present time—What did the tests show as to the merits and demerits of the two brakes tested?

At the outset it should be clearly understood that the triple valve is that part of the brake mechanism on which the success or failure of each brake chiefly hinges; and to make tests which shall be fairly comparable all other parts of the brake must be essentially the same. The best brake is the one which stops a train in the shortest distance, and which stops it with the least shock. But the distance required to stop a train running at a given speed depends on its weight and on the pressure and the friction of the brakeshoes. For practical reasons the Master Car Builders have established a standard limit for brakeshoe pressures, which must not be exceeded; and the increase of brakeshoe pressures by increasing the size of the brake cylinder, the leverage of the foundation gear or the train pipe pressure, while it may cause a quicker stop, counts for nothing in favor of or against any brake.

In the New York Central tests each brake was worked under conditions which were identical in almost every respect. The brakeshoes were all of the same metal and were worn to the wheels; the rolling stock was of uniform make and age; the foundation brake gear was alike on both trains; the brake cylinders were of uniform size; the piston travel was made as nearly uniform as possible; and finally the train pipe pressure was kept as near as possible to the M. C. B. standard of 70 lbs. per sq. in. Thus the question of whether the New York or the Westinghouse brake will make a quicker stop comes down to the question, Which triple valve will put the air pressure into the brake cylinders of 50-car train most quickly?

Turning now to the official report we find "on the face of the returns" that the New York brake train ran 16% farther after the brakes were applied than the Westinghouse. Making allowances for differences of train-pipe pressure, and inequalities due to break-in-twos, and reducing the stops made to equivalent stops at a speed of 30 miles per hour, this figure is increased so that the New York brake shows a record 18% poorer than the Westinghouse.

That these longer runs of the New York train were due in part at least to the less rapid action of the New York triple valve was fully proved by the diagrams of the rise in brake cylinder pressures which were taken in the standing tests. These showed that while the Westinghouse brake was fully applied to its train on the average in 1¾ seconds from the movement of the engineer's valve, the New York brake took 2⅓ seconds. The importance of this difference of 0.6 second is seen when it is remembered that the Westinghouse train was stopped from a speed of 30 miles per hour in only 11 seconds.

But of far greater practical importance than the time or distance in which stops were made is the shocks which accompanied them. This matter is now so familar to railway men and we discussed it so fully in our issues of Feb. 23 and March 2 that we need only repeat here the principal facts, which were that the average shock in the rear cars of the Westinghouse train was 2¾ ins., and in the rear car of the New York train 28 ins. The cause of this greater shock on the New York train was of course the greater length of time required for the application to run through the trains. That is to say, as was shown in the automatic records taken in the standing tests, the New York triple valve is more sluggish in its movement than the Westinghouse.

This sluggish movement of the triple valve, however, does not wholly account for the greater distance which the New York train ran before stopping. As stated above, it ran on the average 18% farther than the Westinghouse train, but it took only 0.6 second longer for it to go on; and this at a speed of 30 miles per hour (44 ft. per second) means simply that it ran 26.4 ft. farther than the Westinghouse train after the engineer's valve opened before the brakes were fully on. As the Westinghouse train stopped from 30 miles per hour in about 325 ft., it appears that the sluggish action of the New York triples should not have increased the length of the stop more than about 8%, provided the pressure in the brake cylinder was maintained.

But as the New York train actually did run 18% farther than the Westinghouse train, the inference is strong that the New York brakes leaked off rapidly after application. The results of the hold-on tests with the trains standing still corroborates this. The New York brakes were found to leak off quite rapidly both in the service and with the emergency application. Also in the release test, which was made by permitting the air to enter the train pipe through a diaphragm perforated with a 3-32-in. hole, the pressure in the New York train pipe rose so rapidly that it was evident that the brakes were leaking back into it. Full proof that this was the case was furnished by the fact that the pressure in the brake cylinders rapidly fell, and at the end of five minutes, when the pressure in the train pipe reached 22 lbs., the brakes had released on 11 cars. At the end of 10 minutes the train pipe pressure had risen to 40 lbs., and 23 more cars had released; 11 more cars released at a train pipe pressure of less than 47 lbs.

On the Westinghouse train, on the other hand, the train pipe pressure was only 10½ lbs. at the end of five minutes. When a pressure of 39 lbs. was reached at the end of 10 minutes, only 9 cars had released.

Another respect in which the New York brake showed a deficiency was in the graduation tests, designed to show the reliability of the brake in service applications. With the train standing still, a reduction of 8 lbs. in train pipe pressure was made, and then at one minute intervals further reductions of 4 lbs. to 6 lbs. were made until the reservoirs and cylinders were equalized. On the New York train the brakes on 11 cars did not apply at all in this test. The test was then repeated with the difference that the full service application was made with a less number of reductions. The result was that three of the New York cars which did not apply in the first tests did not apply in the second; and in addition three cars which did apply in the first test did not apply in the second. On the Westinghouse train the same test was made twice and all brakes applied in both tests.

It is to be regretted that Mr. Dudley does not record how many of the New York brakes failed to apply with the first reduction of 8 lbs. in train pipe pressure; but that 11 cars in one test and 6 in another should not apply at all, even after repeated reductions, such as might frequently be made in service, is a surprising fact. The only possible reason for such action, so far as we can see, was either a very sticky and badly gummed or a very leaky triple-valve piston. Except the serious shocks which occurred in the running tests, this was the most important defect of the New York brake which the tests developed. It is greatly to be regretted that Mr. Dudley did not repeat this test a sufficient number of times to determine just how sensitive the New York triple valves were to graduated reductions of pressure, and did not follow up his work at the close of the tests by taking down the triple valves on the cars whose brakes did not apply, and examining their condition and testing them for tightness.

Reliable graduation in a brake is of vital importance in the safe handling of trains on long grades, and though this may not be important to the New York Central it is a matter of vital interest to hundreds of lines over which New York Central cars may run.

The tests which we have reviewed, considered as a whole, will easily rank as the most complete and carefully conducted competitive brake tests which have ever been made. They shed new and important light on the question, What shall be the standard of merit for the freight car brake, equipment with which is now made compulsory by law? They show that as tested at Karner the New York brake shows serious defects in its practical operation compared with the Westinghouse. It is an important question whether these defects in the action of the New York triple valve are susceptible of remedy, and it is a question which no man can certainly answer. Perhaps better workmanship or material may solve the problem of leakage, but it is doubtful whether it can remedy the sluggish movement of the triple. It seems more likely that this is inherent in the design of the valve itself. That it must be remedied, however, before the New York brake can be safely accepted by the railways admits of no doubt.

It was the sluggish application of the brakes, and the shocks which resulted, that caused the M. C. B. committee to throw over all forms of air brakes, buffer brakes, chain brakes, etc., a few years ago. It was only the marvelous showing made by the Westinghouse brake in 1887, that its triple valve could apply the brakes fast enough to avoid shocks, that led to the adoption of the air brake for freight service.

LETTERS TO THE EDITOR.

INSPECTOR'S HAMMER.

Sir: I think there must have been a mistake in copying the sizes for the inspector's hammer, printed in your issue of April 27, as the 1 11-16 in., should be 1 1-16 in. It makes the hammer very badly out of proportion, and the 1 1-16 in. was intended for the 1-in. rivet-hole—would you kindly correct the error? and oblige.

Yours very truly.

Cleveland, O., April 27, 1893. Jas. A. Joyce.

(The sketch sent us was not to scale and the figures were not very clearly marked upon it. We would impress upon correspondents the necessity of clearness in figures and formulas especially. —Ed.).

WHAT IS THE DISCHARGE OF NIAGARA RIVER?

Sir: In Engineering News of March 9 attention was called to the very peculiar results given in the recent report of observations made to determine the discharge of Niagara River, and, as no explanation has since been published, it is presumed that the engineers who have charge of the work consider their results correct. If such is the case, it would be unjust to expect them to expend government funds in making additional observations. The writer, therefore, will agree to pay all legitimate expenses of a resurvey, made under the direction of the U. S. Engineer Corps, and by approved methods, provided the discharge for mean lake level is not found to exceed that given in report by at least 10,000 cu. ft. per second.

In view of the large amount of money being expended in efforts to deepen the channels of the lake waterways, and the fact that the Chicago Sanitary Canal, when completed, will take 10,000 cu. ft. of water per second from Lake Michigan—an amount shown by these recent observations to equal the increment of discharge of river for a foot and one-half rise above mean lake level—it becomes important that this question should be definitely settled at as early a date as possible.

The observations made by Mr. Francis, at Lowell, by Mr. Ellis on the Connecticut River, and by Humphrey and Abbot on the Mississippi River show that the discharge curve should be approximately that of a parabola, convex to the ordinate of gage-readings, and in all cases giving increasing increments of discharge for higher stages of river surface. The Niagara River discharge curve is the reverse of this, and is the only example of the kind known to the writer.

Some of the errors in the recent work is probably due to the mean velocity curve being plotted from observations made at two different observing sections, and to the basing of curves and formula on the readings of local gage instead of one at the head of the river. The fact that a sudden change of wind on the lake may alter the volume of discharge from 10 to 15%, while the level of river surface at the observing section would change very slowly, may account for some of the peculiarities noted. These, however are of minor importance compared with some greater error in the work, the nature of which cannot be determined from the data given.

With the exception of two observations (shown to be abnormal in the notes from wind effect), those made in 1891 conform very closely with results given by hydraulic formulas.

Assuming that these observations are correct, the relative discharge for higher stages of lake level may be computed by taking the area of cross-section of narrow-gorge near head of river, from the government chart of the river, and computing the slope and coefficients for hydraulic formula from Mr. Quintus' equation of gage relations, and from the actual flow through section, given by observations assumed to be correct.

The theoretical results thus obtained and those from Mr. Quintus' formula, are as follows:

Lake levels.	From Kutter's formula.		From Quintus' formula.	
Buffalo gage.	Discharge. Cu. ft.	Increment. Cu. ft.	Discharge. Cu. ft.	Increment. Cu. ft.
−1 ft.	?20,000	27 000	215,300	14.800
Mean level 0 ft.	247,000	33 ?00	230,100	8,400
+1 ft.	280,0 0	36.0?0	238,?00	3,8?0
+2 ft.	316,?00	38.000	242,3??	1.200

Since the very peculiar results of the last two columns are largely due to the observations made in 1892, it seems quite evident that the source of error

is in that work. If such is not the case, nearly all the hydraulic formulas for the flow of water in streams, heretofore considered reliable will need to be radically revised. Geo. Y. Wisner.

Detroit, April 27, 1893.

NOTES AND QUERIES.

J. R. N. wants to know the value of the ohm in pounds. The ohm is the unit of electrical resistance, which corresponds to friction in mechanics. Its value cannot be expressed in pounds. The nearest approach we can make to what our correspondent asks is to give the equivalent foot-pounds of work which the current that passes a resistance of an ohm is capable of doing. Thus, the ohm is that amount of electrical resistance which will permit enough current to pass under one volt pressure to do work at the rate of 44¼ ft.-lbs. per minute.

THE MOZIER THREE-POSITION SEMAPHORE AND SAFETY SIGNAL.

As we noted in our news columns some time ago, the western lines of the New York, Lake Erie & Western system are now operated on the block system, the signals and appliances, as well as the system adopted, being the invention of Mr. A. M. Mozier, Superintendent of Transportation of the New York, Pennsylvania & Ohio and Chicago & Erie divisions. The system is now in operation between Salamanca, N. Y., and Marion, O., 304 miles, and on single track portions of the Mahoning Division of the N. Y., P. & O. R. R., making 336 miles in all. On May 14 trains over the Chicago & Erie R. R. from Marion to Chicago, 269 miles, will begin operating under the system and the whole of the Erie main line from New York to Chicago will then be operated on the block system.

The distinctive features of Mr. Mozier's system are the use of a three-position semaphore, the electric interlocking of the semaphore with the telegraph key of the operator at the block station to insure the keeping of the semaphore in the danger position, and the control of all trains by the train dispatcher. We show in the accompanying cut a view of the semaphore mounted on a post, and an enlarged view of the hand levers by which the semaphore is operated. The generally accepted positions of the semaphore, horizontal for "danger" and inclined 60° downward for "safety," are not altered, but in addition the semaphore may be made to take a position inclining upward 60° when the order is, "Proceed with caution." The levers by which the semaphore is operated are so fulcrumed that the lever's position corresponds to that of the semaphore, hence the operator is not likely to give the wrong signal through confusing the positions of the lever and of the semaphore. It will be noticed that two chains run from the operating lever to the semaphore. The motion is thus made positive in both directions, and the semaphore must correspond in position with the handle; troubles with semaphores standing half-cocked or sticking when the chain is slacked are thus prevented. The counterweight used serves to return the semaphore from the "caution" position to "danger" unless it is fastened at "caution"; but it cannot drop the blade from "danger" to "safety."

The most important feature, however, is the control of the operator's key. When the levers are in either the "safety" or "caution" position, the circuit through the key is broken, and thus while the operator can receive a message he cannot transmit one until he returns the semaphore to the danger position. Thus, a cardinal principle of good practice in block signaling, that the normal position of the signals shall be at danger, is effectively secured.

As thus arranged the signal may be used either as a train order signal at important stations or as a block signal under the block system.

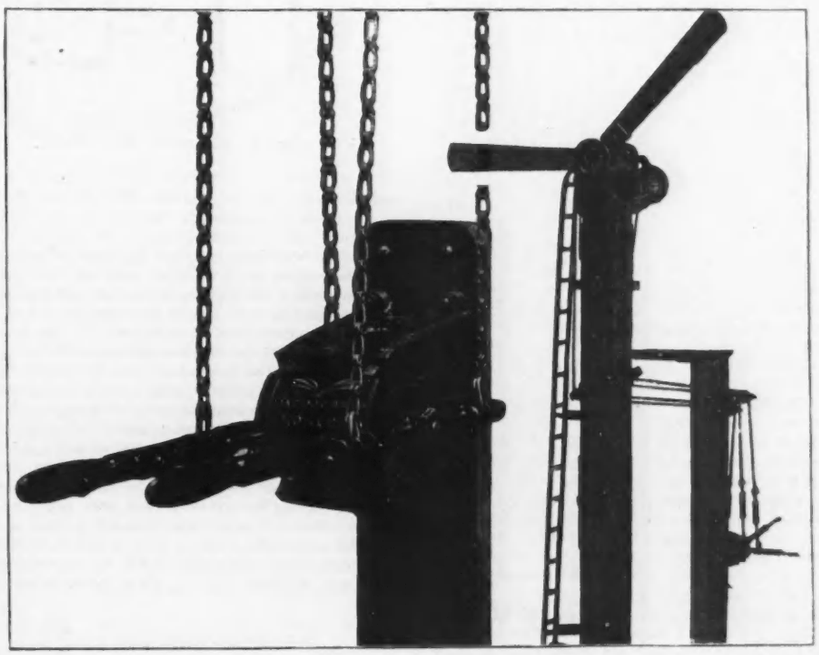
On the western lines of the Erie the block system, using this semaphore as described and illustrated above, was first put in force between Kent and Galion, 93 miles, on July 19, 1891. The train dispatching force, which had consisted of three dispatchers and two operators, was doubled; and to avoid too long blocks six new offices were erected of the usual pattern of block signal stations. Besides this, night operators were put on at nine stations where only a day service had before been required. Under the rules adopted the entire movement of trains is under control of the train dispatcher's office. The station operators merely set their semaphores in accordance with instructions, except in event of interruption of telegraphic communications, when they move trains under caution signals with the aid of information from the block stations on either side. The following are the rules under which the system is worked, and which have been copyrighted by Mr. Mozier, their author:

The section of road between each station will be known as a block, and each station shown on the time table will be known as a block station.

1. The train order signals will be used to govern the operation of the block system as well as for stopping trains when there are orders for them, the right hand arm of signal governing trains as they approach it.

2. When the arm of the signal stands in horizontal position, thus (—) it signifies danger, and requires that an approaching train shall stop before passing it. When the signal arm is elevated to an inclined position of 60°, thus (/), it signifies caution and indicates that the train may proceed under control, keeping a sharp lookout for preceding trains or trains that may be at work between the block stations. When the signal arm is depressed to an angle of 60°, thus (\), it indicates safety, and the train may proceed, provided it can reach the next station without encroaching upon the time of a train of superior rights.

3. The several positions of train order signals, described in rule 2, will be indicated at night by different colored lights at top of signal posts. Red signifying danger, stop; green signifying caution, proceed with care; and white signifying safety, no train on the block.



THE MOZIER THREE-POSITION SEMAPHORE.

4. No train or engine shall be allowed to enter a block while occupied by another train, except that second class trains and extra freight trains running in the same direction may, under direction of the train dispatcher, be allowed to follow each other five minutes apart under green block. Passenger trains following freight trains may be allowed, under direction of the train dispatcher to follow, under green block, ten minutes behind such freight trains.

5. No train shall be allowed to enter a block while it is occupied by a passenger train.

6. Exceptions to the foregoing rules will only be made in case of interruption of telegraph communications so that instructions cannot be received from the train dispatcher, in which case the operator at a block station will hold all trains ten minutes apart, and only allow them to proceed under green or caution signal. He must, however, if possible, first ascertain from the operator at the next block station that no opposing train is on the block, and arrange with him to hold any that may approach.

7. The signal at block stations must be kept in the danger position at all times, and never raised to the caution position or lowered to the safety position until so ordered by the train dispatcher (excepted as provided in Rule 6), and then only to allow the train to pass for which authority has been given by the train dispatcher and for which there are no special orders.

8. Operators at block stations will report as early as possible the approach of each train, except when special orders are awaiting the train, using the numeral 72 when necessary to take the circuit, and if practicable obtain instructions from the train dispatcher as to signal that shall be given without stopping the train. They must also report the departure of trains promptly, but a train must not be reported as having left a station until the rear end has passed 300 ft. beyond the train order signal. Operators must carefully observe the rear end of all trains to see if the customary markers are displayed, and if not they must report the fact at once to the train dispatcher.

9. When an operator reports the approach of a train the train dispatcher will give instructions as to which signal shall be displayed, the following form being used: The operator will report, "No — coming," when the train dispatcher will reply, "red," "green" or "white," as the circumstances may require, signing his initials. The operator will then repeat this signal back to the train dispatcher, signing his own letter and office call and display the signal as ordered. Train dispatcher will, however, when practicable, give instructions in advance as to signals that shall be displayed, and such instructions must be repeated back by the operator.

10. When a train is stopped by the danger signal the conductor and engineman must go at once to the telegraph office to reply to such orders as may be awaiting the train. If there are no orders for the train they will be given a clearance on blanks provided for that purpose, but the train must not proceed until the caution or safety signal is exhibited, which will be done by the express direction of the train dispatcher, except as provided by Rule 6—no train being allowed to leave a station while the signal is at danger.

11. At meeting or passing points where it is necessary for trains to pass the danger signal to pull into side track, or to let other trains pull out of side track, they may do so, but as soon as the track is clear they must be governed by the requirements of Rule No. 10.

12. When more than one train has passed the signal while in the danger position to take side track or to allow other trains to leave the side track, as provided for in Rule 11, the displaying of the safety or caution signal will only allow the leading train to proceed, and after the departure of such leading train the signal must be returned to the danger position until such time as the train dispatcher shall authorize the display of the safety or caution signal to permit a second train to leave, and so on until each train shall have been given the caution or safety signal, separately, authorizing it to proceed.

It must be distinctly understood that the foregoing block signal rules are not to be construed as affecting the rights of any train under the timetable or train rules; nor do they relieve trainmen from adopting all the precautions for protecting their trains that are required by the train rules.

It will be noticed that passenger trains are protected by the absolute block, and permissive blocking is only allowed between freight trains. The number of train orders by this system is increased about 40% over that required with the old plan of working; but the safety, orderliness and relief from anxiety which the system inaugurated make it popular with both dispatchers and operators.

The system was so successful on this section of the road that it has been gradually extended until nearly 600 miles are now operated under it, and with the greatest satisfaction to both officers and employees.

The block system for which there is greatest demand in the United States at the present time is one by which a single-track road crowded with traffic can be operated with reasonable safety and without delaying the movement or reducing the capacity of the road. In addition its first cost and cost of operation must be such as will bring it within the means of poor roads, which can neither invest a large sum in signaling plant nor stand any important increase in operating expenses.

It is claimed that the Mozier signals and system fulfill all these requirements, and that the system has especially great advantages in the increased amount of traffic which can be moved over the road, due to the fact that the trains are all under the immediate control of the train dispatcher.

As operated on the Erie lines, the system seems somewhat open to criticism on account of the absence of distant signals, but this omission is by no means a necessity. The distant signals on each side of the home signal could be added without in any way interfering with the remainder of the system. While they would add something to the first cost of the system, they would add practically nothing to its cost of operation, and the maintenance and repairs account should be very small.

We are informed, however, that the question whether distant signals should be used in connection with single track block signaling was thoroughly canvassed at a meeting of the Erie superintendents and officers after several months' experience with the Mozier block system on the third division, and the decision was against the distant signals. Of course when distant signals are omitted every train should be so run that it can stop before it passes the home signal; and on a stormy or foggy day this means that the speed must be brought down to 10 to 20 miles per hour, or much less in the case of a heavy freight train, as a home signal is approached. When blocks are short this becomes such a serious matter that distant signals are essential; but with blocks four or five miles in length and nearly all the signals located at stations where it is necessary for many trains to stop or slow up anyway it is theoretically possible to run safely without the distant signals and without much loss of time.

As a practical matter, however, the danger in omitting the distant signal arises from the fact that engine runners will not always bring their trains up to the home signal under control. When endeavoring to make up time an engineer is apt to rely on his belief that there is no train ahead of him; and though storm or fog may prevent him from seeing the home signal half a train-length away he will run up to it at good speed.

It does not seem possible to train engineers who have been brought up under the old hap-hazard system of train operation to properly respect the rule that until a home signal is known to be at safety it must be approached as if it were at danger. This being the case, the use of the distant signal, notwithstanding all the objections which have been made to it, seems the safest practice.

The last stone of the masonry dam at Austin, Tex., was put in place on May 2 by Mr. B. J. Corrigan, the contractor. This structure and matters connected with its construction have been described and illustrated in our issues of July 11 and Nov. 14, 1891, April 9, Aug. 18, Sept. 29, Nov. 10 and Dec. 22, 1892, and Jan. 12 and 26, 1893.

The committee of the Brooklyn Bridge Trustees which has charge of the construction of the reconstruction of the New York terminal station, opened bids for the work on May 4, as follows: Levering & Garrigues, $250,000; Milliken Bros., $266,000; Phoenix Bridge Co., $286,000. Seaman & Son bid $105,000 for the carpenter and masonry work. The work was described in our issue of April 20.

STEAM SHOVELS AND STEAM SHOVEL WORK.*

By E. A. Hermann, M. Am. Soc. C. E.

Part 1.—Steam Shovels.

(Continued from p. 410.)

The dipper, scoop, or bucket, is made of iron or steel, shaped somewhat like a coal scuttle. Its cutting edge is protected by four teeth made of steel or steel pointed. These teeth are easily removed for sharpening or replacement. Dippers vary in size from ½ cu. yd. to 2½ cu. yds. capacity. They also vary somewhat in shape, according to the material to be excavated, though no special provision is made for this unless there are very large quantities of the same kind of material to be removed; or for machines working in a certain class of material only, like ore loaders. For general work in all kinds of materials the dipper is seldom changed.

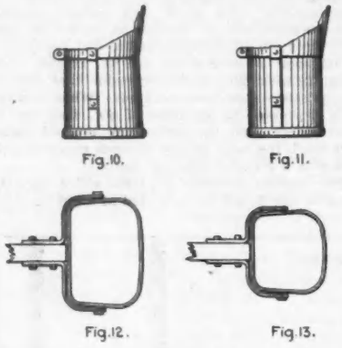


Fig. 10. Fig. 11. Fig. 12. Fig. 13.

Figs. 10 to 13. Buckets for Steam Shovel.

For soft tenacious material likely to adhere to the inner sides of the dipper and not drop out promptly when the bottom door is opened for unloading, the dipper is shaped as shown in Fig. 10, with a larger bottom than mouth. In hard, or dry soft material the section shows parallel sides, as in Fig. 11. For general use the bottom of the dipper should be slightly larger than the mouth, as most materials contain more or less moisture which is likely to produce a partial clogging of the dipper by material sticking to the inner sides, especially between the teeth, necessitating frequent cleaning out whenever the machine is stopped while preparing to move forward, and sometimes oftener. For ordinary clay, cemented gravel, and hard dry materials, a dipper with a wide and shallow mouth, as shown in plan in Fig. 12, is preferred to the one shown in Fig. 13, which latter is better adapted for loose gravel, sand and other soft dry materials where a deep cut can easily be made. For hardpan, shale, loose rock and similar materials, ample strength of teeth and dipper are of greater importance than its shape.

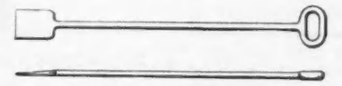


Fig. 14. Spade for Cleaning Buckets.

To prevent tenacious material from sticking to the inner sides of the dipper, and to allow it to drop out freely when the bottom door is opened, it is often good economy to place a barrel of water near the head of the machine from which a bucketful can be taken and thrown into the dipper just before each cut. The water acts as a lubricant and causes the material to drop out more readily. For cleaning the dipper, the tool shown in Fig. 14 is used.

The chains have links of ⅝-in. to 1-in. diameter, and are made of iron, sometimes of steel. Their constant use necessarily subjects them to great wear, and as they are also often exposed to severe shocks (especially the hoisting chain) they must be made of the very best material and in the most careful manner. At present iron chains are preferred to those made of steel; they are more durable, and less likely to break under severe shocks.

TABLE I.—General Description of the Important Parts of the Most Prominent Makes of Steam Shovels.

Fig.	Shovel.	Frame. Material.	Frame. Size, ft.	Running gear.	Gage, ft. ins.	Boiler.	Engine.	Cylinder, ins.		Hoisting gear.	Thrusting mechanism.	Swinging mechanism.	Post. material.	Material.	Working order, ft.	Crane. Ft. above or b'l'w r'l'd or tr'k.	Shipping order, ft.	Dep'th, inch.	Radius, ft.	Swing'g r'n ang. deg.	Capac. of dip. per. cu. yds.	Weight, tons.
1	Osgood	Wood	10 × 34	4 trucks	4 8½	Vert.	Horiz.	Two,	10 × 12	Frict'n clutch.	Reversible engine, 2 steam cylinders each 6 × 8 ins.	Chains attached to circle geared to hoisting drum.	Wt. iron	Wt. iron	35		14		24	240	1	40
	"	"	10 × 30	"	"	"	"	"	8¾ × 10	"	Do., do., 5 × 6 ins.		Cast iron frame.	"	26		14		24	240	1	30
	"	"	10 × 25	"	"	"	"	"	7 × 10	"			Cast iron	"	23		14		20	240	¾	25
2	Thompson	I-beams and chain's.	10 × 32	"	"	"	"	"	8 × 12	"	Rack on dipper handle actuated by friction clutch geared to hoisting drum.		"	"	18		14		20	240	1	40
	"	"	10 × 30	"	"	"	"	"	8 × 10	"			"	"	18		14		20	240	1	30
	"	"	10 × 28	"	"	"	"	"	8 × 8	"			"	"	16		14		20	240	¾	25
	"	"	10 × 24	"	"	"	"	"	6 × 8	"			"	"	12		14		20	240	¾	20
3,4	Barnhart	Wood	10 × 36	"	"	"	Vert.	One,	8 × 10	"			Wt. iron	Wood	30		14		20	200	1	30
	"	"	10 × 26	"	"	"	Horiz.	"	8 × 8	"			"	"	24		14		20	200	1	20
	"	"	10 × 24	"	"	"	Vert.	"	6 × 8	"			"	"	18		14		18	200	¾	16
	"	"	10 × 22	"	"	"	"	"	6 × 6	"			"	"	16		14		18	200	¾	12
5	Victor	"	10 × 30	"	"	"	Horiz.	Two,	8 × 8	"	Reversible engine, 2 steam cyls., 6 × 8 ins... Long st'm cyl., piston rod at ch'd to dipper.	Wire ropes attached to circle and pist'n r'ds in long st m cyl.	Holl w wt. ir'n	Wt. iron	30		14		20	200	1	40
6	Clement	"	10 × 30	"	"	"	"	"	8 × 8	Positive			Cast iron	"	30		14		20	200	1	40*
7	Giant	"	10 × 35A	"	"	"	"	"	13 × 8	Frict'n clutch.	Reversible engine, two steam cylinders, 5 × 6 ins.	Reversible engine, 2 steam cylinders, 5 × 6 ins.; except A, cylinders 7 × 9 ins.	Cast steel	Steel	30		14		19	200	1	40
	"	"	10 × 30	"	"	"	"	"	8 × 7	"			Cast iron	"	18		14		17	200	¾	30
	"	"	10 × 30	"	"	"	"	"	7 × 7	"			"	"	16		14		15	185	¾	20
	"	"	10 × 30	"	"	"	"	"	6 × 6	"			"	"	15		14		15	185	¾	18
8	Little Giant	"	7 × 23	4 road wheels	3 0	"	"	"	6 × 6	"			"	"	15		14		15	185	¾	18
	"	"	6 × 23	4 flange wheels	3 0	"	"	"	6 × 6	"			"	"	15		14		15	185	¾	18
9	Otis-Chapm'n	Wood	10 × 22	4 flange wheels	7 10	"	"	One,	10 × 8	Positive	Chains on dipper handle actuated by friction clutch geared to hoisting drum.	Chains attached to circle, geared to hoisting drum.	Wood	"	29		14		20	200	2¼	25
	"	"	10 × 18	"	7 10	"	"	"	8 × 8	"			"	"	18		14		20	200	1½	15

Makers: 1, (Osgood); Osgood Dredge Co., Albany, N. Y. 2, (Thompson); Bucyrus Steam Shovel & Dredge Co., Bucyrus, O. 3, 4, (Barnhart); Marion Steam Shovel Co., Marion, O. 5, (Victor); Toledo Foundry & Machine Co., Toledo, O. 6, (Clement); Industrial Works, Bay City, Mich. 7, (Giant) and 8, (Little Giant); Vulcan Iron Works Co., Toledo, O. 9, (Otis-Chapman); John Souther & Co., Boston, Mass.

* Copyright, 1893.

Steel chains have suffered in reputation through rapid wear and frequent breakages occurring within the last few years, but with increased experience in their manufacture and use they will undoubtedly be improved, and eventually take the lead over iron chains.

The propelling mechanism consists of an endless chain connecting one or more axles of the truck or supporting wheels with the shaft of the hoisting drum by means of friction clutches or positive gearing. The usual speed is five to six miles per hour.

Steam shovels of seven of the most prominent manufacturers are shown in Figs. 1 to 9, and the general particulars of each are given in condensed form in Table I. In each case the boiler is upright.

Operation of Steam Shovels.—All movements of the steam shovel are controlled by two men, the engineman and the cranesman. The former is stationed near the engine, the latter on a small platform attached to the crane. The engineman directs the movements for raising and lowering the dipper, swinging it into position for unloading, and moving the machine forward or backward. The cranesman regulates the depth of the cut made by the dipper, releases it from the bank when full or near the top of the crane, and pulls the spring latch of the bottom door of the dipper when in position for unloading, thereby dumping its contents.

These motions are shown in Figs. 15 and 16. Beginning with the dipper in the position shown at A, Fig. 15, the engineman throws the hoisting drum into gear, and starting the engine pulls the dipper upward, the cranesman at the same time thrusting it forward, regulating the depth of the cut so that it will not stop the engine or tip up the rear end of the machine. When the dipper has reached the position B, near the top of the crane, the engineman throws the hoisting drum out of gear, and holds it in position with a foot brake; at the same time the cranesman, by easing his foot brake, allows the dipper to fall back to the position C. The engineman then swings the dipper over the car or wagon, as shown in Fig. 16, when the cranesman pulls the latch rope, thereby opening the bottom door of the dipper and dropping the contents. The engineman then swings the crane back again to the next cut, at the sametime releasing his foot-brake on the hoisting drum until the dipper has fallen to a point near the ground, as at D, Fig. 15, where he holds it for an instant with the foot-brake, then drops it by releasing the brake, while the cranesman (during this slight drop) regulates the length of the radius of the dipper handle by releasing his foot-brake so as to bring the dipper into the position A again, and adjoining the last cut. While the dipper is being lowered, the bottom door closes and latches itself by its own weight, when all is ready again for another cut.

These motions are very simple when taken separately, but when performed together by two different men, experience and quickness in both are required to carry on the work rapidly and harmoniously, without breakages on delays. In loose gravel one cut can be made in a half to three-quarters of a minute; in hard materials one and a half to two minutes, seldom more.

After all material within reach of the dipper has been removed, an unoccupied section of track (generally about 4 ft. long) at the rear of the steam shovel is attached to the dipper by a chain and dragged around the machine to the front (by swinging the dipper horizontally) and there placed in position in line with the sections of track under the machine. The screws at the ends of the jack arm (a horizontal bar at the front end of the machine used for steadying it when cuts are taken at right angles to the steam shovel) are then released, and the machine moved forward three or four feet by throwing the propelling gear into motion. After placing the jack screws into their new position, and tightening them, and blocking the supporting wheels of the steam shovel, the machine is ready for another series of cuts.

The regular employees for operating a steam shovel are the engineman, cranesman, fireman and four laborers. The latter are under the supervision of the cranesman, and their duties are to shovel forward any lumps or loose material which may roll down and lodge too close to the front of the steam shovel to be reached by the dipper, to level the surface of the ground in front of the machine, preparing it for the next section of track, to lay these sections of track, to attend to the jack screws and blocking and to act as general utility men.

With this crew dry sand and loose gravel can readily be loaded. In harder or more tenacious materials from two to six extra men are required,

Fig. 17. Pole for Breaking Down Edge of Excavation.

depending upon the kind of material to be excavated, and also upon good management of the contractor or foreman in charge. Wet sand and fairly loose gravel requires only two extra men, whose duty is to break down the overhanging ledges or these materials which cannot be reached by the dipper, and are liable to fall when the machine has advanced, burying it or blocking the pit behind it. The implement used by these men is a pole, Fig. 17, headed by an iron point, resembling a surveyor's pole. With these poles fairly loose gravel and sand can be readily broken down, sloped at its natural angle, and fed into the pit in front of the steam shovel. In harder materials three to four extra men are usually sufficient, but in very hard or tenacious materials as many as six must be employed. These men break down overhanging material in the face of the bank which cannot be reached by the dipper, bore or drill holes for powder or dynamite when blasting becomes necessary, cut and remove trees, etc.

On all but very small pieces of railway work there are also employed a blacksmith and helper, and two to five car repairers. The blacksmith's work consists mostly of repairs about the cars, mainly bent or broken aprons, sideboards, chains, etc. The steam shovel occupies much the smaller part of his time. His accomodation requires a small rough frame shop about 10 × 16 ft. (an old box car body is frequently used), with forge and tools. Another rough frame shed of about the same size is needed for the storage of tools, oils and supplies. The sectionmen of the respective sections are occasionally called on for the building and maintaining (or taking up) of the various side tracks required during the progress of the work.

(To be continued.)

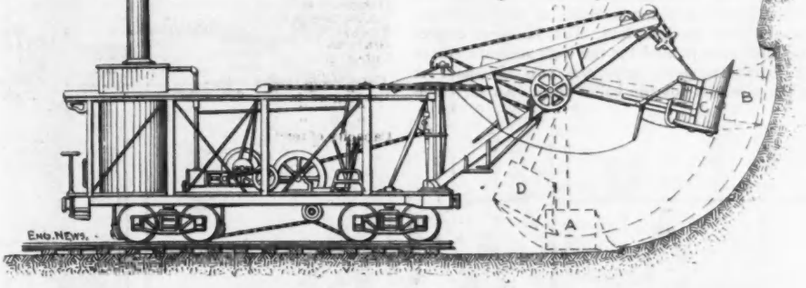


FIG. 15. SHOWING SERIES OF OPERATIONS FOR EXCAVATING WITH STEAM SHOVEL.

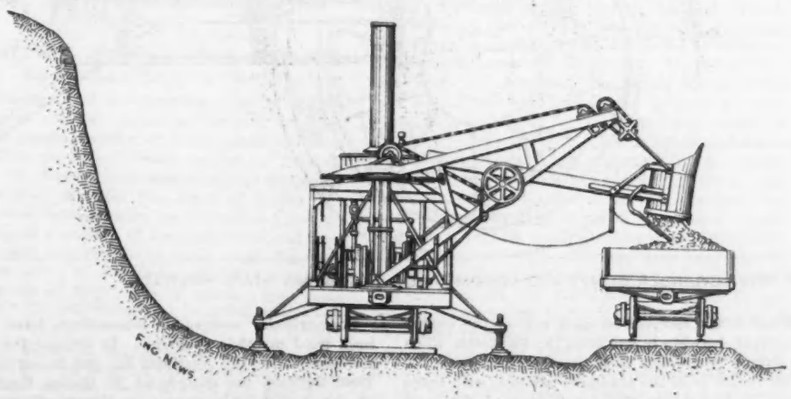


FIG. 16. LOADING EARTH FROM STEAM SHOVEL ON TO CARS.

FOUR-CYLINDER COMPOUND LOCOMOTIVE; HUNGARIAN STATE RAILWAYS.

The increase of the use of compound locomotives of different types on European railways, and the growing favor with which the American eight-wheel type of locomotive is being regarded by these railways, have been pointed out in our issues of March 9 and April 6. In the latter issue we illustrated and described a four-cylinder compound locomotive of the eight-wheel type, built for the Southwest Ry. of Russia, and we give this week particulars of a somewhat similar engine on the Hungarian State Railways, built at the railway shops at Budapest.

The engine is of the eight-wheel type with outside cylinders, there being a high and low-pressure cylinder on each side with a single piston rod. The cylinders are horizontal, and the low-pressure cylinders are at the front of the engine, while in the Russian engine (Eng. News, April 6), the cylinders are inclined and have the low-pressure cylinders next the cross-head. On both engines the valves of each pair of cylinders are operated by a single valve gear. The Hungarian engine has the eccentrics outside the frames (another almost exactly similar engine has the Walschaert's valve gear), and the valves on the same valve stem, while the Russian engine has the eccentrics between the frames, and has separate valve stems operated by the same valve rod, as shown in the drawings already published.

The firebox is of the Belpaire pattern, with inclined grate, and is inside the frames and between the driving axles, the driving wheels being

also inside the frames. The slide valves are inclined, as shown in the cross-section of cylinders, and the low-pressure valve has a back plate to prevent its rising from its seat. The receiver consists of two separate pipes in the extension front of the smokebox, connecting the high-pressure exhaust on one side with the low-pressure valve chest on the other side in such a way that the engine is operated like two independent, two-cylinder compound engines on the Mallet system. There are no separate packings where the valve stem between the two valves passes out of the valve chests, but the stem has a continuous bearing, as shown. The guide bars are sufficiently far in advance of the front cylinder cover to allow of the cover being taken off without taking down the guides. The high-pressure piston is fixed permanently to the piston rod, and the low-pressure piston is attached to the same rod by a key and split pin, so that it can be readily removed. The glands of the stuffing boxes between the cylinders are screwed up by hollow nuts running on a thread turned on the outside of the stuffing box, the hollow nuts being prevented from slacking back by a spring plate engaging in notches on the nuts.

The dome is large, and is placed close to the smokebox end of the barrel of the boiler. A plain cylindrical smokestack is used, and there is an extension front to the smokebox. The driving springs are connected by equalizing levers, the springs and levers being above the running board. There is an iron cab with small windows in front and two windows on each side, as in the engine illustrated in our issue of March 9. The engine is fitted with the Westinghouse train brake. Tests were made with cylinders of different proportions before the dimensions given for this engine were adopted. The proportions were 14.8 and 20 ins. diameter, 13 and 22 ins. diameter, and 13.6 and 19.2 ins. diameter, all of 26 ins. stroke. In the design of this engine the following conditions were imposed: 1, to haul a load on the level, and on grades of 0.6% with sharp curves at speeds of 37 and 50 miles per hour, respectively; 2, to burn lignite, evaporating 5 lbs. of water per pound of fuel; 3, the weight not to exceed 14 tons per axle; and 4, to be able to run on turntables of 44 ft. diameter without uncoupling the tender.

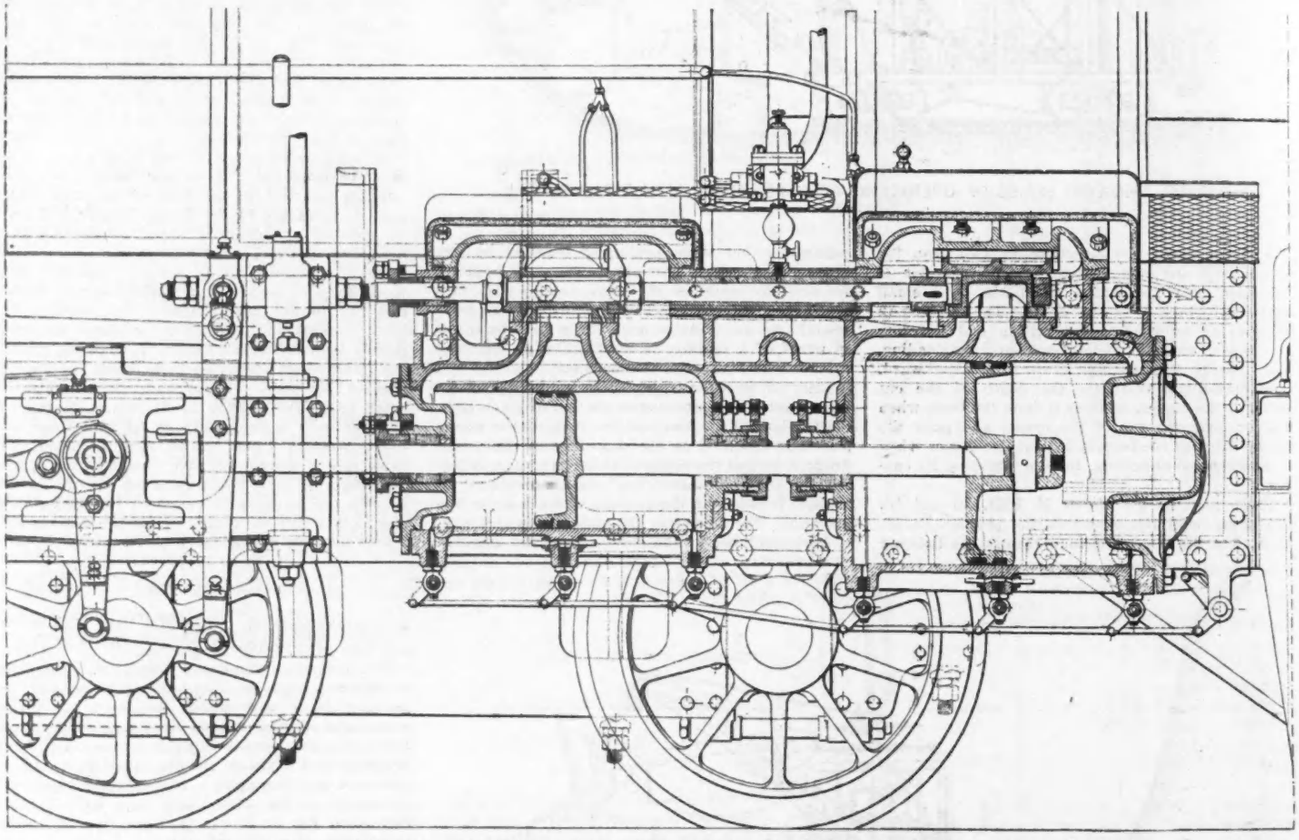
The boiler is of Martin mild steel, with a copper firebox and steel tubes with copper ferrules. The center line of the boiler is 7 ft. 4 ins. above the rails. The main frame and truck frame are of mild steel plates, and the truck has a socket bearing for a hemispherical steel center plate carried by the main frame. Each pair of cylinders is cast in one piece. To facilitate starting, an intercepting valve is fitted to admit live steam to the receiver and low-pressure cylinder. A screw reversing gear is used, operated by a hand wheel. The connecting and coupling rods are of I-section. The smokebox has an extension front with spark arrester on the American plan, an arrangement which is adopted on many of the locomotives of the Hungarian State Railways, and found to be indispensable with lignite fuel.

There are two Gresham sand jets, operated by air from the Westinghouse brake reservoir, and a Petri speed indicator is fitted, as on all the express engines on this line. The Kordina continuous lubricator is used for the high-pressure valves and cylinders, and there are two Gresham & Craven injectors for the boiler feed. An air valve is fitted to the receiver on each side of the engine to prevent drawing in gas from the smokebox when the engine is running with the throttle closed.

The tender is of the standard pattern, with three axles. It has a capacity for 8 tons of coal and 4,500 gallons of water, sufficient for a run of 2½ hours. The frame is outside the wheels. The springs, like those of the driving and truck wheels, are of the type used on the Belgian State Railways (Eng. News, July 18, 1891), and have no deflection when not under load.

The engine hauls, in regular service, over a line with grades of 0.5 to 0.6% trains of 150 to 170 tons, the maximum speed not exceeding 50 miles per hour on the level. In trial runs, it hauled trains of eleven first and second class cars, weighing 160 tons behind the tender, or 225 tons in all, at speeds of 37 miles per hour on grades of 0.6%, with sharp curves, and 50 miles per hour on the level. On a line with heavy grades a train of ten cars, or 125 tons (20% more than the winter load for the older express engines), has been hauled at speeds of 20 to 23 miles per hour on 2% grades, and 23 miles per hour on a grade of 1.6%, with a curve nearly the entire length of grade. The engine rode very steadily. The general dimensions of the engine are as follows:

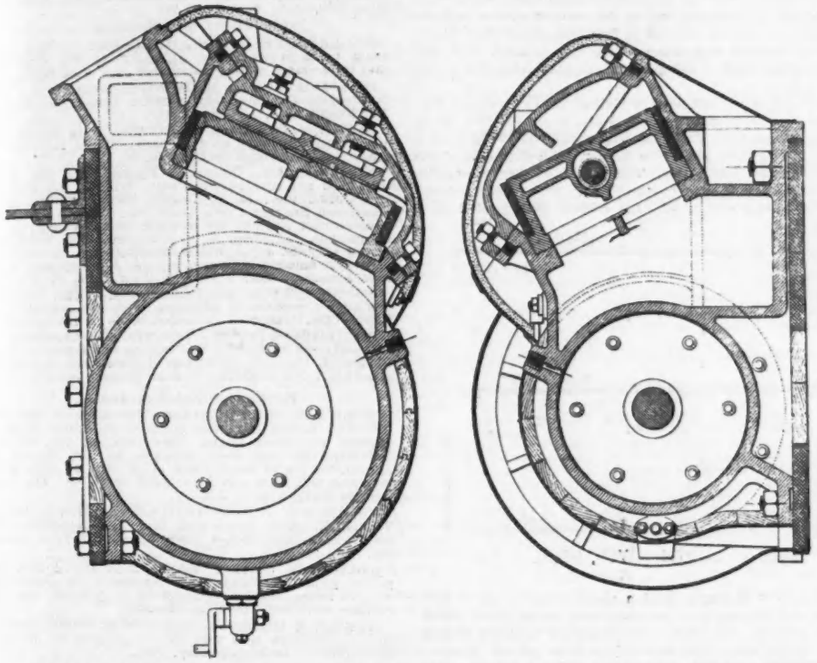
Driving wheels, diam.	6.56 ft.
Truck wheels, "	3.45 "
Wheel base, driving	7.87 "
" " total	20.60 "
Length of engine, over buffers and footplate.	32.30 "
Width of engine, over all	10.30 "
Weight in working order, on drivers	61,508 lbs.
" " " " on truck	58,422 "
" " " " total of engine	119,930 "
" " " " tender	89,286 "
" of engine and tender	209,216 "
" of engine empty	110,230 "
" of tender empty	34,171 "
Cylinders, h. p.	13.6 × 26 ins.
" l. p.	19.2 × 26 "
Ratio of area, h. p. to l. p.	1 to 2.1
Boiler, height of c. line above rails	7.38 ft.
Firebox, Belpaire	8.72 × 3.64 "
Grate area	32.28 sq. "
Tubes, number	188
" diam. outside	2 ins.
" length between tube plates	13.12 ft.
Heating su face, tubes	1,322.4 sq. ft.
" " firebox	129.1 "
" " total	1,451.5 "
Capacity of tender tank	4,488 galls.
" " " coal space	17,636 lbs.



SECTION THROUGH CYLINDERS OF FOUR-CYLINDER COMPOUND LOCOMOTIVE; HUNGARIAN STATE RAILWAYS.

Four-cylinder compound locomotives have also been tried in other countries. In France the first was one which the Northern Ry. put in service in 1886, built by the designs of M. Glehn, Engineer of the Societe Alsacienne de Constructions Mecaniques, and the same road has now two more eight-wheel engines of similar design, but more powerful, in which each pair of cylinders operates one of the two driving axles. In 1889, the Paris, Lyons & Mediterranean Ry. built two four-cylinder engines, the high-pressure cylinders, 12.4×24.8, inside the frames and driving one axle; the low-pressure cylinders, 20×24.8 ins., outside, and driving another axle. In 1892 this railway built two eight-wheel engines somewhat similar to those of the Northern Ry, with inside high-pressure cylinders between the truck axles, driving the front driving axle, and outside low-pressure cylinders behind the truck, operating the rear drivers. The driving wheels were coupled. The Vau-

clain four-cylinder system, so largely used in this country and on American engines sent to South America, was described and illustrated in our issue of Feb. 20, 1892. In this system the two cylinders on each side are placed one above the other, with piston rods connected to the top and bottom of the cross-head between them. Still another arrangement is that of the four-cylinder compound



SECTION THROUGH CYLINDERS AND VALVE CHESTS OF FOUR-CYLINDER COMPOUND LOCOMOTIVE; HUNGARIAN STATE RAILWAYS.

locomotives of the Mexican Central Ry. (Eng. News, Aug. 29, 1891; March 12 and 26 and April 2 and 9, 1892), designed by Mr. F. W. Johnstone, Superintendent of Motive Power and Machinery, in which the high-pressure cylinders are placed inside the low-pressure cylinders. A four-cylinder simple engine of the eight-wheel type, with one pair of inside cylinders driving the forward driving axle, and a pair of outside cylinders driving the rear driving axle, was described in our issue of April 13.

THE AMERICAN TYPE OF COAL CARS FOR EUROPEAN RAILWAYS.

The advantages of the American type of freight car of large carrying capacity for coal, ore and other bulk freight handled in large quantities have been pointed out several times, and in our issue of April 13 we showed their superiority to the small European coal cars for this class of traffic. In Italy these advantages have been found in practical experience, as a number of American type coal cars of 60,000-lb. capacity have been used for coal traffic, as noted in our issue of Feb. 16, 1893. The economy of these cars in service has been worked out by the "Jornal del Lavori Pubblici" as follows:

We have calculated the utility to be obtained by using these cars for carrying coal, basing our calculations on the quantity carried, 1,152,975 tons from Genoa. With 12-ton cars at least 96,081 cars were employed; and as all were returned empty, and calculating the dead weight of each as 7½ tons, we find that the railways have transported a dead weight of $7\frac{1}{2} \times 2 \times 96{,}081 = 1{,}441{,}215$ tons, which, added to paying load, 1,152,975 tons, shows that the railways have carried a total gross weight of 2,594,190 tons. If this coal had been carried by 30-ton cars, there would have been used 38,432 cars, the tare or dead weight of which is 10 tons each, making the dead weight transported to and fro 768,640 tons. This added to the paying load of 1,152,976 tons makes the total weight carried by the railway 1,921,916 tons. Therefore had these light weight, high capacity cars been used last year carrying the same class of traffic, they would have effected a saving of the transportation of 672,575 tons. Calculating that on the Genoa line the gross weight of a train, exclusive of locomotive, does not exceed 300 tons, it results that the railway company would have saved 2,262 trains. The majority of this coal being for Milan and Turin, we will presume that these 2,262 trains would have run an average of 93 miles each; therefore, if a train-mile costs the railway 60 cts. for traction, we have a saving here of $203,580. This saving is in itself enormous, but it must be added that with the 30-ton cars there would have been 86,868 less wheels and axles to care for, 57,649 less cars to register, each requiring two registrations, and an immense saving in wear, tear and lubrication, owing to the smoothness with which they run as compared with the rigid wheel-base four-wheel cars heretofore in use.

RAILWAY FROM ACRE TO DAMASCUS.

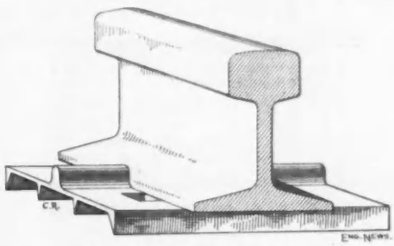
The railway in Syria (Syria Ottoman Railway), mentioned in our issue of March 2 as being practically in the same territory as the Beirut & Damascus Railway, described in that issue, will hardly be a direct rival of that line, according to information received from the promoters of the Syria Ottoman line. The Beirut & Damascus Railway will run southwest from Beirut to Damascus. The Syria Ottoman Railway will start from Akka (or Acre) and Haifa (on both sides of the bay of Acre, considerably south of Damascus and 60 miles south of Beirut), run southwest to the Jordan River, and then northwest to Damascus, so that the two lines reach Damascus from opposite directions. Work on this latter line was commenced in December, 1892, and about five miles are now approaching completion, while under the terms of the construction contract the line must be in operation to the Sea of Galilee by the end of February, 1894, and to Damascus by the end of 1895.

Sir Douglas Fox, Chief Engineer, states in his report to the company that the surveys for a line to the north of the Sea of Galilee proved that the mountainous character of the country and the deep ravines intersecting it would offer serious obstacles to the economical construction of a railway. He therefore adopted a route by the plain of Jezreel and passing to the south of the Sea of Galilee. From the coast the grades are easy until the line rises from the Jordan Valley, 832 ft. below sea level, to the Bashan or Hauran plateau, 1,150 ft. above sea level. This ascent is sidehill work, with a grade of 2½%, and involves about ten miles of comparatively heavy work. From the summit the works are very easy. Damascus is 2,160 ft. above sea level. The total length of the main line will be 145½ miles, with a branch of 3½ miles to Haifa. About 83% of the alinement is on tangents, and the maximum grades are 2½% going east and 2% going west.

The plans show 13 tunnels, aggregating about 5,250 ft., but this may be reduced. The bridges and culverts will be of native masonry. The track will be laid with 60-lb. steel rails on creosoted pine ties. There will be 27 stations, including the termini, with passenger and freight accommodation, water supply, shops, etc., and harbor works are to be carried out at Acre. Several branches are projected. Damascus has a population of about 250,000, and is the starting point for caravans in Persia, Arabia, etc.

SERVIS COMBINATION TIE PLATE.

The Servis steel tie plate with flat upper surface and two or three ribs on the under side to bite into the wooden tie (Eng. News, April 2, 1892) has been on the market for some years and is now in extensive use on a number of railways. An objection which has been made to it is that while it prevents the cutting of the tie by the rail, it leaves the outward thrust on the rail to be resisted by the spikes. Other makes of tie plates have been introduced which have lugs or ribs, parallel with the rail, against which the outer edge of the rail



Servis Combination Tie Plate.

flange abuts, leaving the spikes to their more legitimate duty of holding the rail and plate to the tie.

The Servis combination tie plte, which we illustrate this week, is similar to the ordinary plate, but has a surface rib at right angles to the rail, cut away for the width of the flange to allow the rail to rest on the plate, and thus holding both sides of the rail, and relieving the spikes from lateral pressure. This will require a special make of plate for every width of rail flange, a play of about 1-16-in. being allowed to provide for irregularity in width. This plate is manufactured by the Q & C Co., of Chicago.

OTTOMAN RAILWAY.

The Ottoman Railway, from Smyrna to Aidin, is one of the oldest railways of Asia Minor, having been commenced in 1858, and opened to Aidin in 1866. The following particulars of this line are taken from the company's report of the half year ending Dec. 31, 1892. The operating expenses amounted to 41.46% of the gross receipts. There are 321 miles built, out of a total of 372¾ miles authorized. The company's lines in operation consist of the main line from Smyrna to Dineir, the Tireh branch and its extension to Odemish, and the Denizli, Tchivril, and Sokia branches, with two leased branches (2½ miles); in all, 321 miles. The equipment is as follows: Locomotives, 51 (33 with tenders and 18 tank engines); tenders, 35; passenger cars, 130 (17 first class, 15 composite, 65 second class, 30 brake, 3 baggage); freight cars, 1,155 (38 brake, 308 box, 266 high sided open, 516 low sided open, 15 brake tenders, 12 pier trollies). The train-mileage for the half year was as follows:

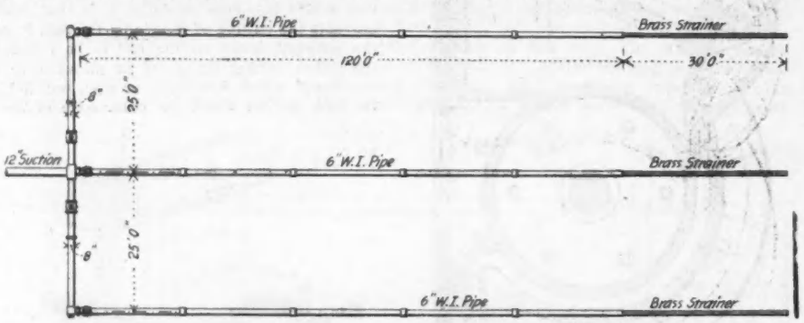
	Miles.
Mixed trains, passenger and freight	463,278½
Switching, empty and other trains	131,908
Total	595,186½
Trains run without locomotives	3,603½
Total miles run by engine	591,583

A further extension of the line eastward from the present terminus is proposed and also a branch from Balachick to Sokia, 13¾ miles, for which latter 5% bonds for $500,000 are now being issued. The negotiations with the Turkish Government for authority to extend the line eastward have not been very successful, as concessions have been granted to other and newer companies for lines in

the same territory. As the conditions proposed to the government by these companies were not as favorable to the government as those proposed by the Ottoman Ry. Co., it is supposed that some political deals are involved in the transactions, after the usual manner of affairs in the East. A concession has been granted to a German company, and the Ottoman Ry. now proposes to extend its line to a connection with the German company's line. Mr. Edward Purser is General Manager and Chief Engineer.

HORIZONTAL TUBULAR WELLS AT SOUTH HAVEN, MICH.

In 1892 water-works were built by the village of South Haven, Mich. The supply is pumped from three 6-in. Cook tubular wells, with 30-ft. strainers pushed out horizontally, or nearly so, beneath the sandy bottom of Lake Michigan for 150 ft. The approximate arrangement of these wells is shown by the accompanying plan. The tubes were pushed out beneath the lake by means of hydraulic jacks. It is stated that the wells have yielded 1,250,000 gallons of water per day. At the desired location for the wells there was only about 8 ft. of sand at the bottom of the lake, which would not permit the use of the ordinary vertical wells with good results, as a sufficient length of strainer could not be obtained.



PLAN OF COOK HORIZONTAL TUBULAR WELLS AT SOUTH HAVEN, MICH.

Horizontal wells have also been put in by the Cook Well Co. beneath the Missouri River for the Willow Springs Distilling Co., Omaha, Neb.; beneath the Mississippi River for the Laclede Gas Light Co., St. Louis, Mo., and for the Crystal Plate Glass Co., Crystal City, Mo. At the latter place two 8-in. wells, with 65-ft. strainers, were pushed out about 200 ft. at a slope of 1 to 3 in a strata of sand about 20 ft. deep. These two wells have yielded 1,300,000 gallons in 24 hours.

The strainers made by the Cook Well Co. and used at South Haven are of brass with slits cut at right angles to the axis of the strainer. In the 6-in. strainers there are nine rows of these slits, with six slits to the inch, or 648 slits per lin. ft. of strainer, making 20,440 slits to each of the three wells at South Haven, or 61,320 in all.

The width of the slits is varied to suit the different sizes of sand in which the wells are driven.

We are indebted to Mr. L. D. May, of the Cook Well Co., Chamber of Commerce Building, Chicago, for the information regarding the wells; and to Mr. H. E. Dewey, of South Haven, Mich., for some facts regarding the water-works, of which the latter is superintendent.

It may be added that on March 28, 1893, there were six miles of mains and 130 taps in use at South Haven, and that the average daily consumption of water was given as 40,000 gallons.

FOUNDATIONS OF THE TOWER BRIDGE.

At the meeting of the Institution of Civil Engineers on March 28, 1893, a paper was read giving an account of the methods adopted in the construction of "The Foundations of Two River Piers of the Tower Bridge," by Mr. G. E. W. Cruttwell, M. Inst. C. E. The London "Architect" gives the following abstract:

Owing to the weight of the lofty towers supporting the suspension chains of the shore spans and the high-level footways over the opening span of the bridge, the dimensions of the foundations, with a load of 4 tons per superficial foot, worked out to 100 ft. in width by 204½ ft. from end to end of the cut-waters. This large area was excavated by sinking four caissons, each 2? ft. square, on the north and south sides of each pier, with two triangular-shaped caissons at each cut-water. The twelve caissons of each pier were all spaced 2 ft. 6 ins. apart, and inclosed between them a rectangular space, 34 ft. by 124½ ft., in the heart of the pier. This was not excavated until the permanent work forming the outer portion of the pier had been built continuously within the caissons and in the narrow spaces between them up to the level of a few feet above high-water. This method was cheaper and was attained with less risk than that of using larger caissons extending across the pier.

The caissons consisted of a single skin of wrought iron varying in thickness from ½ in. at the bottom to ¼ in. at the top. The skin was supported every 3 or 4 ft. in height by pitch-pine frames, with diagonals of the same material across. The joints of the removable portions were made water-tight with India-rubber. The bottom section of each caisson was erected on a temporary platform fixed a short distance above low-water. Two pairs of trussed-beams were placed above the caisson, with their ends supported upon the staging on either side, and four 2½-in. rods passed between the beams, and were connected to the caisson near each corner. The rods were screwed at the top for several feet, and, by setting up the screws, the caisson was slightly lifted, while the platform was cleared away from beneath. The caisson was then lowered down onto the bed of the river and the excavation was commenced. Divers and grab-machinery were employed at first; but, as the ground consisted of the London clay, it was only necessary to sink the caissons some few feet beneath the river bed, when the water could be pumped out of them, and the excavation continued in the dry.

The reliable nature of the clay rendered it possible to undercut beneath and beyond the bottoms of the caissons, whereby a considerable saving was effected in contracting the limits of the caissons within the outside line of the foundations. The undercutting was timbered with 1½-in. poling-boards, strutted back with timber props against the bottom of the foundations. By executing the undercutting in sections and quickly filling in the concrete as soon as the excavation of each section was completed, the danger that was liable to arise from any serious swelling of the clay was much diminished. After two adjoining caissons had been sunk and partially filled with concrete, the space between them was inclosed by driving piles in grooves specially provided at the corners of the caissons. This allowed the adjoining sides to be removed and the intervening space to be excavated and concreted up, thus converting the two caissons into one. By repeating the process a continuous caisson surrounding the heart of the pier was obtained. Within this the outer portion of the pier was built to a height of 4 ft. above Trinity high-water, thus forming a cofferdam to exclude the tide from the inner portion of the work. When the latter had been pumped out and excavated the inner sides of the caissons were taken out and the heart of the pier was filled in. The whole work was bonded together by numerous dovetails in the concrete, and by toothings and rackings in the brickwork.

The materials in the two piers, from foundation line up to a level of 4 ft. above Trinity high-water (a height of 60 ft.), consisted of 25,220 cu. yds. of cement concrete, 22,400 cu. yds. of brickwork in cement, and 3,340 cu. yds. of Cornish granite, making a total of 50,960 cu. yds. The cost of the same, including all subsidiary items, such as stagings, caissons and excavations, amounted to £111,122, or about $555,610; the average cost of the construction was $10.54 per cubic yard.

A large dredge has been built by Beatty & Sons, of Welland, Ont., for the Welland Dredging Co. Length, 107 ft.; beam, 35 ft.; depth of hold, 9 ft.; daily capacity in clay, 2,500 to 3,000 cu. yds.; weight, 30 tons; cost, $30,000.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

DELAWARE & HUDSON CANAL CO.—It is stated that the Adirondack & Schroon Lake R. R. Co. will be organized to build the proposed extension to Schroon Lake, N. Y., noted last week.

CANADIAN PACIFIC.—The contracts for the extension of the Atlantic & Northwestern Ry., west from Eganville, Ont., have been let.

Projects and Surveys.

BELLEFONTE & MILL HALL.—Surveys are being made for a railway from Bellefonte to Mill Hall, Pa., and it is stated that construction will soon begin.

GRAND RIVER & MAHONING.—Surveys are now in progress for this Ohio railway. Pres., Jas. Ritchie, 185 Euclid Ave., Cleveland, O.

OLEAN, OSWAYO & EASTERN.—It is stated that work will be commenced at once on this railway line from Genesee Forks to Oswayo, N. Y.

NEW JERSEY.—Chartered Tennis Cons. Co., Camden, N. J.; to construct railways, bridges, water-works, gas works, etc.; E. A. Tennis, Thompsontown, Pa.—Chartered Roaring Creek Cons. Co.; Jersey City, N. J.; to construct railway up Roaring Creek Valley; T. H. Gimbernot, Plainfield, N. J.—Chartered, The Pecos Co., Jersey City, N. J.; capital stock, $5,000,000; to construct railways, electric railways, etc.; J. J. Hagerman, Colorado Springs, Colo.; C. A. Otis, New York, N. Y.

BOYNE CITY & SOUTHEASTERN.—This company has been organized in Michigan to build a railway from Boyne City, Mich., to hardwood lands in the vicinity.

PHILADELPHIA & PITTSBURG.—Chartered in Pennsylvania to build a railway 45 miles long through Clearfield, Cambria, Jefferson, Indiana and Armstrong counties, from Mahoffey to near Kittanning, Pa.

Southern.—Existing Roads.

MOBILE & BIRMINGHAM.—The work on the new line into Mobile from the junction, 2½ miles north of Mobile, has been begun. The contract for building the new line has been awarded to Mr. Wilson, of Macon, Ga., who has a force of 60 men at work grading, and will soon add 20 or more to these. The work will be completed by July 1.

RICHMOND, NICHOLASVILLE, IRVINE & BEATTYVILLE.—It is announced that this Kentucky railway will be extended a short distance beyond Irvine, Ky.

ABINGDON COAL & IRON.—It is stated that this partly graded railway from Abingdon to Damascus, Va., 15 miles, has been purchased by persons who will resume work and complete the line.

MOBILE & OHIO.—At their coming annual meeting the stockholders will vote on the proposition to build an extension to Montgomery, Ala.

Projects and Surveys.

HOLLY RIVER BOOM & LUMBER CO.—The contract for building this 17-mile West Virginia railway has been let to Joseph Fuccy, Sutton, W. Va., and it is reported that work will begin at once.

Northwest.—Existing Roads.

ILLINOIS CENTRAL.—Engineers, stated to be in the employ of this company, are surveying a line from Kenny to St. Louis, Mo.

JACKSONVILLE SOUTHEASTERN.—It is stated that this company has purchased the branch between Springfield and Havana, Ill., which it has been operating under a lease for some time past. Work will be commenced at once on the entire reconstruction of the road. New bridges and new rails are to be put in and the line placed in first class shape.

WINONA & SOUTHWESTERN.—An election will be held soon to vote on the question of granting a 5% tax in aid of an extension from Osage to Mason City, Ia.

Southwest.—Existing Roads.

TEXAS & GULF.—This company is making bids for building 36 miles of railway. C. D. Lancaster, Texarkana, Tex., Secy.

GALVESTON, SOUR LAKE & EASTERN.—Construction is in progress on this road, noted in our issue of April 13. Ch. Engr., W. A. Polk, Houston, Tex.

Projects and Surveys.

TEXAS.—Surveys have been made for a railway from Sugarland to Arcola, Tex., 12 miles.

WICHITA FALLS & OKLAHOMA.—This company has been organized to build a railway from Wichita Falls to Ringgold, Tex. Among the incorporators are: M. Lasker, Galveston, Tex., W. L. Vickers and R. M. Moore, Wichita Falls.

GULF, BEAUMONT & KANSAS CITY.—Ch. Eng. L. F. Daniell, Beaumont, Tex., began the survey of this line May 1.

Pacific.

Projects and Surveys.

SAN DIEGO & PHOENIX.—This company has been chartered in Arizona and its organization completed by electing the following officers: Pres., D. C. Reed; Vice-Pres., M. E. Collins; Secy., G. H. Merrill. The capital stock is $3,500,000. The road is projected from Phoenix, Ariz., to San Diego, Cal, and it is stated that surveys will soon begin.

ELECTRIC RAILWAYS.

BURLINGTON, VT.—Work will soon begin changing the motive power of the street railway to electricity.

PHILADELPHIA, PA.—Chartered, The Frankford, Bridesburg & East Fairmount Park Ry. The line begins at 33d and Thompson Sts., on 33d to Glenwood Ave., to Ontario, to Glenwood or Venango St., to Jasper to Wheatsheaf Lane, to Sepviva, to Ashland, to Stiles, to Frankford road, to Melrose, to Bridge; thence returning by same way, being double track along its entire route; to be operated by electricity; capital, $78,000. The officers are: Pres., George W. Rush; Directors, James F. Gossmer, Daniel M. Collamer, Joseph N. Rush, John W. Frazier, Joseph S. North, Joseph F. Lamorelle, William B. Gill.

WABASH, IND.—Preliminary steps have been taken to organize a street railway company. Jas. McCrea.

ALEXANDRIA, VA.—Surveys have been made for an electric railway. L. W. Spear.

ATLANTA, GA.—The White Electric R. R. Co. will build a 5-mile line.

COLUMBUS, GA.—The North Highland St. R. R. Co. has petitioned city council for right of way over seven miles of streets. It intends constructing an electric-power station for street-car motors and for lighting the city.

WAYCROSS, GA.—An electric street railway is talked of.

KNOXVILLE, TENN.—The motive power of the West End St. Ry. will be changed to electricity.

DUBUQUE, IA.—Incorporated. The Dubuque Light & Traction Co.; capital, $600,000; George K. Wheeler, Chicago, is President; Walter J. Ballard, Chicago, Vice-President; Edward W. Duncan, Dubuque, Secy. and Treas. The other directors are John L. Martin and James D. Cummins, Chicago. The new company represents the General Electric Co., Boston, and has bought the Allen & Swiney electric light and street railway plant from the Old Colony Trust Co., Boston.

HORSE AND MOTOR RAILWAYS.

CLINTON, MASS.—Chartered, Clinton St. Ry. Co.; capital stock, $30,000; length, 3 miles; Andrew J. Witherell, Treas.

NEW ORLEANS, LA.—The St. Charles street railway system in New Orleans, it is understood, is to be equipped with motors operated by ammonia-gas as a motive power.

ELEVATED RAILWAYS.

CHICAGO, ILL.—The contracts have been let for putting in the foundations for the Lake St. elevated railway to the western city limits, or Fifty-second St. The work is progressing rapidly, and is to be completed in three months. The bridge foundations are also in. The Phoenix Bridge Co., of Phoenixville, Pa., is putting up the superstructure, including the bridge from Canal to Market Sts. The Chicago Surveying & Engineering Co., J. Q. Baird, Gen. Man., has been engaged to have charge of foundation work, and Mr. Baird informs us that 100 tons of iron are being received daily for the structure west of Western Ave.

BRIDGES, TUNNELS AND CANALS.

LEBANON, N. H.—There is talk of constructing a highway bridge over the Connecticut River at this point. Estimated cost $18,000 to $20,000.

CARLTON, N. Y.—There is a movement on foot to build a bridge over Oak Orchard Creek. Estimated cost $5,000.

TROY, N. Y.—The incorporators of the Troy & Green Island Bridge Co. have organized by electing the following officers: Pres., Chas. Cleminshaw; Vice-Pres., D. J. Whelan; Treas., Anthony N. Brady, and Secy., Thos. S. Fagan.

BALTIMORE, MD.—The city council has passed an ordinance appropriating $20,000 for a bridge across Jones Falls at Maryland Ave.

COLUMBUS, O.—The city engineer has prepared plans for a bridge over the railway tracks on Front St. Estimated cost $44,820.

KANSAS CITY, KAN.—The county will issue $13,000 of bonds to construct a bridge across the Kaw River at Bonner Springs.

HIGHWAYS.

NEW JERSEY.—The board of freeholders of Union county has ordered that plans be prepared for macadamizing Newark Ave., Newark turnpike and Morris Turnpike. This work is to be done in connection with Essex county.—The board of freeholders of Burlington county has awarded contracts for roads as follows: Riverton to Westfield, awarded to B. M. & J. F. Shanley, Philadelphia; Moorestown to Mount Laurel, Barbour & Ireland, Newark; Beverly to Cooperstown, and thence to Charlestown, Thos. J. McGovern, Philadelphia.

OHIO.—The auditor of Franklin county will receive bids at his office, Columbus, until May 31, for the improvement of Kenwood Ave., in Clinton. The work includes 1,750 ft. of 5-in. curb, 9,840.19 ft. of brick sidewalk, 561 sq. yds. of gutters, 1,658 lin. ft. of 5-in. drain, 5,058 cu. yds. of excavation, about 2,200 sq. yds. of cement and Hayden block sidewalks, etc.—The auditor of Lawrence county, Cincinnati, will receive bids until May 23 for $50,000 of turnpike bonds.

CALIFORNIA.—The board of public works of San Diego will construct a highway to connect that city with National City, four miles distant.

WATER-WORKS.

New England.

AUBURN, N. H.—An examination of possible sources of water supply is being made.

HANOVER, N. H.—The Hanover Water Co. has been organized. It is reported that a part of the stock may be taken by Dartmouth College.

FALL RIVER, MASS.—Authority has been secured to issue $200,000 of bonds for new work.

MEDFORD, MASS.—The clerk of the water board wishes bids for 26 hydrants.

NORTH ANDOVER, MASS.—The selectmen are to engage an engineer to make plans and estimates for works.

BOSTON, MASS.—The contract for building the filter bed, located at Natick, has been awarded to Aug. Saucier, South Framingham, for $4,235.

BROOKFIELD, MASS.—A contract for laying 5,000 ft. of pipe has been awarded to Orlando & Sweeney.

FORT WARREN, MASS.—Bids are wanted until May 31 for furnishing and laying a line of 6-in. cast iron pipe between Gallops Island, Boston Harbor, and Fort Warren. Lieut. LeRoy S. Lyon, U. S. A.

WEBSTER, MASS.—The town has accepted the act allowing it to build works.

GUILFORD, CONN.—The Guilford Water Co. has been incorporated; $25,000.

Middle.

DOLGEVILLE, N. Y.—The village board has organized as a water board.

GLENS FALLS, N. Y.—The people have voted $80,000 for replacing cement mains with cast iron.

SILVER CREEK, N. Y.—Plans for works are being made by Alex. Potter, New York city.

BAYONNE, N. J.—The council has appointed a committee of five to consider the obtaining of water from some other source. Water is now bought from Jersey City.

JERSEY CITY, N. J.—Three bids for a new supply, delivered at the Belleville reservoir, have been received. The Moffett, Hodgkins & Clarke Co., New York, offers to supply water from the Rockaway, according to the amount, the prices for a daily supply of 25,000,000 gallons and for all above 35,000,000 gallons being as follows: Through steel pipe, $39.75 and $25; through two cast iron pipes, $45 and $25; through one cast iron pipe, $39.25 and $25.

The Montclair Water Co. offers a supply from the Passaic River and tributaries, above the great falls, at $43 per million gallons.

Hugh J. Riley, New York, offers a supply from the Rockaway River, above Powerville, for $40 per million gallons for the first 25,000,000 down to $32 for all in excess of 35,000,000 gallons.

FREEMANSBURG, PA.—There is talk of gravity works from Nancy Run Creek, to be owned by a company.

HARRISBURG, PA.—The council is considering filtration.

MILLVALE, PA.—June 7 the people, it is reported, will vote on issuing $80,000 for works. A company now furnishes a supply.

WASHINGTON, D. C.—Bids for furnishing cast iron pipe will be received until May 15. J. W. Ross, M. M. Parker, Wm. T. Rossell, Comrs. D. C.

Southern.

KEYSER, W. VA.—The people have voted 396 to 18 in favor of works.

PIEDMONT, W. VA.—The people have voted for works, 312 to 110.

North Central.

NORWOOD, O.—Bids for $25,000 of 5% bonds are wanted until May 23. W. E. Wichgar, Clerk, 137 Walnut St., Cincinnati.

KNIGHTSTOWN, IND.—The people have voted for works.

LA GRANGE, IND.—Plans for works are being made by Voorhees & Witmer, Buffalo, N. Y.

ROCHESTER, IND.—Engrs. Voorhees & Witmer, Buffalo, inform us that bids for the works complete were as follows, including 37,000 ft. of 4 to 12-in. cast iron pipe, 80 6-in. hydrants, 51 valves and valve boxes, brick inlet well, pumping station and chimney, pumping machinery, including two 4½ × 16-ft. steel boilers, and 12 × 125-ft. steel stand-pipe: Mr. Merrigold, $37,082; E. A. Rudiger, Nebraska City, Neb., $37,250; Cook & Read, Cleveland, O., $38,487; Mr. Newcomer, Chicago, $40,911; Walton & Wagner, Rome, Ga., $44,605; J. T. Hutton, Rochester, Ind., $44,922; Bonghen Engineering Co., Cincinnati, O., $45,300; Hinds & Bond, Watertown, N. Y., $57,238. There were 30 bids on separate portions of the work, the aggregate of the lowest bids being less than $35,000.

ROCKVILLE, IND.—It is reported that a vote in favor of works has been taken.

TIPTON, IND.—The citizens have voted for works.

CENTRALIA, ILL.—The city has received the following bids for building works: W. S. Reed & Co., Chicago, $56,530; Geo. C. Morgan, Chicago, $47,074; T. A. Hartman, $45,500; Jas. Stewart & Co., St. Louis, $44,900; E. Sutphin, $44,760; C. F. Sturtevant, $42,919; C. F. Stookey, Belleville, $42,500; Chas. F. Tobin, Hillsboro, $41,000; E. T. Sykes, Minneapolis, $39,890.

FORT SHERIDAN, ILL.—J. G. Falcon, Evanston, Ill., has been awarded the contract for examining, repairing and relaying the water-works pipe line.

HIGHLAND PARK, ILL.—Bids for works are wanted, as stated in our advertising columns. W. S. Shields, Engr., Chicago.

Southwestern.

KAUFMAN, TEX.—A proposition to build works has been made. An artesian well has been proposed.

COLORADO SPRINGS, COLO.—Bids for cast iron pipe and for water bonds are wanted, as stated in our advertising columns.

LOUISVILLE, COLO.—Works are proposed; estimated cost, $15,000.

Northwestern.

KINGSLEY, IA.—Bonds for works have been voted.

HARBINE, KAN.—The Harbine Water Co. has been incorporated; $300; H. H. Kimball, A. C. Dunn and others.

FREMONT, NEB.—Bids are wanted for a 133,000-gallon steel stand-pipe; estimated cost, including foundations, $5,340.

SEWERS.

GARDINER, ME.—The city council has voted to appropriate $5,000 for sewers, and to issue bonds for $25,000 to put in the sewers most needed.

HOLYOKE, MASS.—Bids are asked until May 16 for 15,000 lin. ft. of 12 to 20-in. vitrified sewer pipe, with privilege of ordering 50,000 lin. ft., to be delivered f. o. b. in this city. R. B. Holmes, Chn. Com.

LENOX, MASS.—Plans for a sewerage system are being prepared by Chas. A. Allen, Worcester. It is hoped to have the pumping station completed in June.

MALDEN, MASS.—The city engineer will receive bids until May 18 for 34,000 ft. of vitrified sewer pipe and 3,900 bbls. of cement.

NORTHAMPTON, MASS.—W. W. Strong, Cy. Engr., informs us that the sewer commissioners are considering plans for 1,200 ft. of 48-in. brick sewer, average cut 8 ft., estimated cost, $7,000; and 17,000 ft. of 8 to 12-in. pipe sewers, estimated cost $25,000.

EAST PROVIDENCE, R. I.—Bids are asked until May 16 for 18,000 ft. of 26 to 20-in. brick sewer, and 1,000 ft. of 15 to 6-in. pipe sewer. Geo. F. Hunter, Town Clerk. See advertisement.

AMSTERDAM, N. Y.—The sewer commissioners will receive bids until May 18 for about 4,000 ft. of sewers.

BUFFALO, N. Y.—The department of public works will receive bids until May 17 for six 12 to 24-in. tile sewers.

IRVINGTON, N. Y.—The contract for a system of sewers has been awarded to P. H. Harrison & Sons, Newark, N. J., at $33,000.

JAMAICA, N. Y.—The sewer commissioners desire descriptions and drawings of sewerage systems.

MEDINA, N. Y.—M. A. Bowen has been elected president of the sewer board. Bids will soon be asked for the sewer in West St.

ROCHESTER, N. Y.—Bids will soon be asked for the construction of the West Side sewer; estimated cost, $386,000 to $450,000.

YONKERS, N. Y.—A contract has been awarded to John A. Murphy at $32,500.

EAST ORANGE, N. J.—J. J. O'Neill, Township Engr., informs us that the town expects to construct three or four miles of sewers this year.

NEW BRUNSWICK, N. J.—A contract has been awarded to Herbert Tate, New York, at $9,000.

OCEAN CITY, N. J.—E. B. Lake informs us that he has been granted a franchise for a sewerage system, and that he expects to award the contracts within a few days.

ASHLEY, PA.—Bids are asked until May 15 for sewers in several streets. John Brunner, Chr. sewer com.

EASTON, PA.—The department of sewers will advertise for bids for sewer pipe, and for the construction of an arch.

GREENSBURG, PA.—Bids will be received until May 15 for 2,000 ft. of 10-in. sewers. E. H. Bair, Burgess.

ROYERSFORD, PA.—The street committee has been authorized to receive bids for the construction of sewers.

MACON, GA.—An election will be held next month to vote on the issue of sewer bonds for $200,000.

CLEVELAND, O.—The board of control will receive bids until May 31 for sewers in five streets. The following bids were received for a sewer in Forest St.: James Connelly, $25,183; Campbell Bros., $21,855; J. & P. O'Donnell, $21,777; Kuentz Bros., $20,416; William Eggers, $19,919; W. J. Gawne, $19,885; Clement Bros. Con. Co., $19,600; Ford P. Beers, $19,442; McCarthy & Sager, $19,044; Garry & Fahey, $17,949.

JACKSON, MISS.—A committee of ten business men has been appointed to investigate the cost of a system of sewers.

NORWOOD, O.—Plans and specifications have been prepared for sewers in 14 streets.

PAINESVILLE, O.—The village clerk will receive bids until May 18 for a sewer in district No. 1.

FRANKFORT, IND.—A. J. Hammond, Cy. Engr., informs us that 4,000 ft. of 10 to 18-in. pipe sewer will soon be constructed.

HAMMOND, IND.—The contract for about 19,000 ft. of sewer, part brick, has been awarded to T. W. Kinser & Son, Terre Haute.

QUINCY, ILL.—Work will soon be commenced on 19 blocks of sewers.

MARINETTE, WIS.—Bids are asked until May 16 for about six miles of sewers. J. K. Setright, Cy. Clerk. See advertisement.

WASHBURN, WIS.—It is reported that plans have been completed for a complete system of sewerage, and that the construction will soon be commenced.

ST. PAUL, MINN.—Bids will be received until May 15 for 26,900 lin. ft. of pipe and brick sewers, one contract, varying from 9 to 24 ins. for pipe and 3 to 3.5 ft. for brick, estimated cost $48,000; also for smaller contracts, aggregating about $4,000. Geo. L. Wilson, Asst. Cy. Engr.

KANSAS CITY, MO.—Plans are being prepared for a 4.5-ft. sewer, estimated to cost $50,000.

TOPEKA, KAN.—The state board of public works will receive bids until May 22 for a sewer for the Girls' Industrial School, Beloit. Wm. Wykes, Secy.

FREMONT, NEB.—The board of public works has been directed to advertise for bids for the completion of the sewerage system, the contract to be awarded to the lowest bidder.

EXCELSIOR SPRINGS, MO.—It is reported that the citizens have voted in favor of a sewerage system.

INDEPENDENCE, MO.—J. H. Taylor is chairman of a committee appointed to urge the necessity of a sewerage system before the council.

WACO, TEX.—The issuing of sewer bonds for $20,000 is being considered by the council.

DENVER, COLO.—The city engineer has prepared plans for a sewer 8,000 ft. in length, and estimated to cost $200,000 to $250,000. This sewer is urged by the health department as a sanitary necessity.

GLENWOOD SPRINGS, COLO.—The contract for a sewerage system has been awarded to J. A. McIntyre, B. P. Wickham and Henry Hember, Denver.

SNOHOMISH, WASH.—Engineers are preparing surveys and plans for a system of sewers.

STREETS.

ALBANY, N. Y.—The board of contract will receive bids until May 15 for paving Delaware Ave. with asphalt. The residents of North Albany desire two streets paved with granite.

BUFFALO, N. Y.—Bids have been opened for paving in several streets, those for Broadway being as follows: German Rock Asphalt Paving Co., Trinidad Lake asphalt, $31,946; Barber Asphalt Paving Co., $32,426; P. B. McNaughton, John Porter brick, $25,671; dressed Medina block, $38,000.

ITHACA, N. Y.—The contract for paving Tioga and Cayuga Sts. has been awarded to Costello & Naegle, Elmira.

NEW YORK, N. Y.—The commissioner of public works will receive bids until May 16 for 19 contracts for flagging, grading, etc. Bids are also asked until May 19 for traprock screenings, grading, etc., in wards 23 and 24.

NORTH TONAWONDA, N. Y.—A. P. Austin is a member of a committee appointed to secure the paving of certain streets.

ROCHESTER, N. Y.—The contract for paving Grand Ave. with asphalt has been awarded to the Rochester Vulcanite Co., at $58,382.

EAST ORANGE, N. J.—J. J. O'Neill, Township Engr., informs us that the town expects to construct at least two miles of macadam streets this year.

GREENSBURG, PA.—Bids are asked until May 15 for about 10,000 sq. yds. of paving with firebrick, 6,000 lin. ft. of 6-in. stone curbing, and 1,000 cu. yds. of grading. E. H. Bair, Burgess.

HOMESTEAD, PA.—The contract for paving Ann St. with vitrified brick has been awarded to Erbeck Bros., at $14,647.

BALTIMORE, MD.—The city commissioner will receive bids until May 20 for paving two streets with Trinidad Lake asphalt, and one with asphalt blocks.

COVINGTON, KY.—The common council will receive bids until May 15 for $148,218 of paving bonds.

ASHTABULA, O.—The following bids were received for paving Main St.: M. W. Harris & Co., Chicago, Ill., $20,133; W. J. Hays & Son, Cleveland, $23,159; Spitzer & Co., Toledo, $27,027; Geo. A. Lewis & Co., Chicago, Ill., $28,011; Farson, Leech & Co., Chicago, Ill., $28,027; Lamprecht & Co., Cleveland, $20,411; Sensongord & Mayer, Cincinnati, $20,281; Dietz Dennis Bros., Cleveland, $29,112.

CINCINNATI, O.—The board of administration will receive bids until May 24 and 31, for paving with brick. The contract for paving Knowlton St., in Cumminsville, has been awarded to Frank Kirchner & Son, at $26,000.

CLEVELAND, O.—The board of control will receive bids until May 17 for improving Gaylord St., and until May 31 for repaving five streets with block Medina sandstone.

DAYTON, O.—The city comptroller will receive bids until May 15 for about 15,000 sq. yds. of paving with Medina blocks, Hayden blocks, Hallwood blocks, asphalt or brick.

HAMILTON, O.—The city clerk will receive bids until May 16 for improving East Ave. by grading, gravelling, etc.

LIMA, O.—Bids will be received by R. H. Gamble, Asst. Engr., until May 25 for 12,635 sq. yds. of brick paving. See advertisement.

PORT HURON, MICH.—Petitions have been presented for paving several streets.

MILWAUKEE, WIS.—The board of public works has asked for $30,500 for repairing sidewalks.

FRANKFORT, IND.—A. J. Hammond, Cy. Engr., informs us that he has prepared plans for 21,000 sq. yds. of brick paving, estimated to cost $45,500. The work has not been advertised.

HAMMOND, IND.—T. W. Kinsert & Son, Terre Haute, were the lowest bidders for about 26,380 ft. of macadam and other improvements, which, including sewers, will cost about $140,000.

INDIANAPOLIS, IND.—Contracts for paving with brick have been awarded to Acme Paving & Cement Co., two streets, $5.47 and $5.83 per lin. ft.; Hines & Jenkins, one street, $6.68.

DECATUR, ILL.—Bids are asked until May 15 for 20,000 sq. yds. of brick paving. W. P. Shade, Chn. Com.

NORMAL, ILL.—The town council is considering several petitions for paving.

QUINCY, ILL.—Contracts will soon be awarded for paving six blocks with brick. Contracts have already been awarded for paving 13 blocks.

WAVERLY, IA.—The city council is considering plans for paving several streets.

RICH HILL, MO.—Bids are asked until May 23 for building sidewalks. J. Z. Phillips, Acting Cy. Engr.

ST. LOUIS, MO.—The board of public improvements will receive bids until May 23 for the annual contracts for repair of streets, 36 contracts.

HOUSTON, TEX.—Contracts have been awarded for 6.5 miles of brick paving, to cost about $400,000.—The Omaha & South Texas Land Co. has awarded a contract to Hengen & Hipp for shells for several streets at Houston Heights, at $35,000.

DENVER, COLO.—The Colorado Paving Co. has been incorporated by A. L. Barber, F. Y. Greene and others; capital stock, $250,000.

ELECTRICAL.

PORTLAND, ME.—It is reported that S. D. Warren & Co. will put in an electric power plant at the Presumpscot Lower Falls. The company has had this matter under consideration for some time, and three years ago built a building for this purpose at the falls.

HAMBURG, N. Y.—Bids have been opened for 2,000 c. p. arc lights, which are estimated to cost about $70 each per year. The Hamburg Water & Electric Co. furnish 22 lights, and two extra ones if desired, and water for the new park, for $1,540 per year for three years. Bert Pierce offers to furnish 23 lights, with an extra one for the park, and incandescent lights for use in the bandroom, at the same price.

MARBLE FALLS, TEX.—A. R. Johnson is interested in a proposed electric light plant at this place.

NEW COMPANIES.—Norwood Construction & Electric Co., Norwood Park, Ill., $20,000; E. D. Smith, Nels Sampson, James A. Low, New York Electric Co., Chicago, Ill. $25,000; J. W. Firestone, G. W. Bryson, C. J. Brachman, Richmond Electric Light Co., Richmond, Mo.; $18,000; Thos. N. Lavelock, Robert Hughes, John Gibson.

CONTRACT PRICES.

SEWERS.—Rochester, N. H.—J. F. Springfield, City Engr., informs us that the lowest of seven bids received for the construction of the proposed sewers was that of Bartlett, Gay & Young, Manchester, as follows: 18 and 15-in. pipe, 72 cts. per lin. ft.; 12-in., 70 cts.; 10-in., 60 cts.; 8-in., 57 cts.; 6-in., 43 cts.; rock excavation, $4 per cu. yd.; manholes, $3.50 per vert. ft.; total, $32,714.

Salt Lake City, Utah.—The following bids were received May 3 for the proposed gravity sewer: 1, Houlahan, Griffith & Co., Salt Lake City, $367,327 for a brick and concrete sewer, or $381,949 if entirely of brick; 2, A. Rosewater, Omaha, Neb., $438,989, or $475,899; 3, John M. O'Rourke, Denver, Colo., $349,-302.60, or $428,212; 4, J. S. Morse & Son, Salt Lake City, $491,397.50, or $520,247; 5, Sullivan, McDonald & Co., Salt Lake City, $375,383.00, or $431,883; 6, Wickham Bros., Council Bluffs, Ia., $674,847.55, or $641,127; 7, Ryan, Griffith & Co., Council Bluffs, Ia., $394,856.10, or $394,252; 8, McConnell & Miller, Council Bluffs, Ia., $453,787.80, or $517,627. The sewer is to be constructed of concrete and brick masonry or entirely of brick as may in the judgment of the board of public works and city engineer be deemed best after the bids have been considered. It is to be circular in form and there will be 17,500 ft. of 64-in. sewer, 9,800 ft. of 54-in., 3,600 of 48-in., 5,300 of 42-in., and 5,200 ft. of 38-in. The walls will be 12 ins. thick where 54 ins. or more diameter, and where less than 54 ins. they will be 8 ins. thick.

The prices were as follows:

	1.	2.	3.	4.	5.	6.	7.	8.
Earth excavation, 73 700 cu. yds., at	$0.40	$0.19	$0.38	$0.87	$0.50	$0.75	$0.28	$0.33
Earth excavation and backfilling, 116,000 cu. yds., at	.49	.86	.54	.19	.59	.88	.60	.59
Solid rock excavation, 10 cu. yds., at	6.00	1.95	1.90	2.80	1.00	3.25	1 60	5.00
Solid rock excavation and backfilling, 50 cu. yds., at	7.00	5.50	2.40	3.00	1.00	3.90	2.00	5.75
Embankment, 500 cu. yds., at	.25	.30	.38	.30	.25	.40	.22	.24
Tunneling in earth, 25 lin. ft., at	11.25	4.50	3.00	8.50	8.00	4.25	4.50	9.60
Tunneling in solid rock, 350 lin. ft., at	17.00	7.50	13.00	16 00	12. 0	14.00	9.50	9.60
Concrete masonry, 500 cu. yds., at	4.50	8.00	6.00	15.00	5.00	7.00	7 50	6.90
Brick masonry, 25,400 cu. yds., at	6.50	10.00	9 00	25.00	6.00	11.25	10.50	9.60
Cut stone masonry, 5 cu. yds., at	20.00	30.00	39.00	45.00	30.00	40.00	26.00	30.40
Rubble masonry, 200 cu. yds., at	9.95	12.50	11.15	11.25	11.50	16.44	10.50	14.40
Rubble masonry laid dry, 200 cu. yds., at	6 00	5.45	8.95	7.00	6.00	13.50	7.75	7.80
Cement plaster, 65,370 sq. yds., at	.30	.35	.48	.10	.40	.44	.28	.39
Riprap, 500 cu. yds. at	2.00	5.50	3.60	5.00	3.00	4.00	1.00	4.79
Lumber in place, 200 M., at	30.00	30.00	34.00	35.00	30.00	30.00	28.00	21.00

ASPHALT PAVING.—Philadelphia, Pa.—The director of public works has awarded contracts for paving narrow streets and alleys with sheet asphalt on broken stone at $2.42 per sq. yd., and on concrete at $2.65, for streets from 12 to 20 ft. wide, while those of less width will be paved with granolithic, at $2.30 and $2.70 per sq. yd., respectively.

Hudson, N. Y.—The contract for paving Warren St. with asphalt blocks has been awarded to the Hastings Asphalt Improvement Co., at $2.50 per sq. yd., the pavement to be kept in repair for five years.

REMOVING COBBLESTONES.—Hudson, N. Y.—The contract for removing the cobblestone paving in Warren St., from Third to Seventh Sts., has been awarded to Shute & Rightmyer, at 9 cts. per sq. yd., other bids being Marks Kearney, 12 cts.; T. F. Carbine, 15 cts.; D. Hester, 16 cts.

CEDAR BLOCK PAVING.—Minneapolis, Minn.—A contract for 38,000 sq. yds. of paving with cedar blocks has been awarded to James E. Snyder at about 85 cts. per sq. yd.

BRICK PAVING.—Decatur, Ill.—We are informed by W. P. Shade, Chn. Com. on Pub. Imprvts., that a contract for paving about 28,000 sq. yds. with vitrified brick has been awarded to P. H. Hunt & Co., at $1.65 per sq. yd. Bids are asked for additional work, as noted elsewhere.

GRAVEL PAVING.—New Orleans, La.—The following bids have been received for paving with concrete gravel: J. B. Gribble, $1.12 per sq. yd., or with Chatawa gravel, $1.40; Rosetta Gravel Co., $1.50; C. Julian Bartlette, $1.40; James Hoskins, $1.24.

GRANITE PAVING.—Albany, N. Y.—The following contracts have been awarded for paving with granite blocks: R. H. Strong, A, paving 420 sq. yds., $3.45 per sq. yd.; B, new curb, $1.35 per lin. ft.; C, circular curb, $1.40; D, crosswalk, 60 cts. per sq. ft.; E, relaying granite, 60 cts. per sq. yd.; F, credit price for cobblestone, 1 ct. per sq. yd.; G, for old curb, 1 ct. per lin. ft.; H, receiving basin, $90. P. H. Reilly, A, 632 sq. yds., $3.25; B, $1.30; C, $1.30; D, 25 cts.; E, 40 cts.; F, 2 cts.; G, 4 cts.; H, $70. Jacob Hoiler, A, 2,050 sq. yds. at $2.73, 10.25 sq. yds. at $2.95; B, 60 cts., $1.35; C, $1.35; D, 35 cts., 30 cts.; E, 50 cts.; G, 5 cts.; H, $75 each.

Lewiston, Me.—The contract for the paving to be done the present year has been awarded to Frank W. Dana, at $1.55 per sq. yd. for furnishing and laying granite blocks.

STONE, BRICK AND MACADAM PAVING.—Fremont, Neb.—The commissioners of Douglas county received the following bid from Riley, McDonald & Penfield for paving three roads: Colorado sandstone on concrete, $4.55 and $4.80 per sq. yd.; on broken stone, $4.75 and $5; on sand, $4.65 and $4.90; brick, $4.25; telford macadam, $3.50; macadam on concrete, $3.25.

MACADAMIZING, FLAGGING, ETC.—Montclair, N. J.—Contracts for macadamizing roads, crosswalks, etc., have been awarded to the lowest bidders at prices published last week.

BRICK, STONE, ETC.—Baltimore, Md.—The following bids have been received for material for the Ramsay St. bridge: Brick, Pitcher & Creager, $8 per M.; J. R. Busey & Son, $8.20; Chas. F. Nitch, $9; Y. O. Wilson, $8.10. Stone, two kinds, A. Weber, $2.35 and $2.35 per cu. yd.; J. T. Curley & Co., $2.25 and $3.25; J. G. Schwind, $2 and $2.75; David Leonard, $1.95 and $2.65. Lumber, Georgia and North Carolina, P. M. Womble, $21.40 and $13.40 per M. ft., B. M.; Wm. D. Gill & Sons, $22.50 for Georgia lumber.

EXCAVATION.—Detroit, Mich.—The lowest bid for excavating the northeast marsh on Belle Isle, about 166,000 cu. yds., was that of M. J. Griffin, 28 cts. per cu. yd.

IRON.—Wilmington, Del.—The contract for iron for the new filter has been awarded by the water commissioners to the Remington Machine Co., at 5.4 cts. per lb. for wrought iron and 3¾ cts. for cast iron.

PIPE.—Salt Lake City, Utah.—The following bids were received for 586 tons of 4 to 12-in. water pipe: W. A. Wetmore, $35.65 per ton; Addyston Pipe & Steel Co., $42; Colorado Fuel & Iron Co., $36.50; Chattanooga Foundry & Pipe Works, $36; Rhodes Bros., $34.55.

Buffalo, N. Y.—The department of public works recommended the following bid for acceptance: Buffalo Cast Iron Pipe Co., pipe, all sizes, $24.50 per ton; ordinary special castings, $45; dry sand specials, $55; delivery on streets, $1.50.

DREDGING AND PIER WORK.—Cleveland, O.—Col. J. A. Smith, U. S. Engineer Office, has opened the following bids for dredging about 250,000 cu. yds. in the straight channel at Sandusky Harbor, a distance of about 9,000 ft., the project providing for a width of 200 ft. and a depth of 17 ft. throughout: Cassin, Stickney & Cram, East Saginaw, Mich., 13.5 cts. per cu. yd., measured in scow; E. R. & J. M. Sewall, Albany, N. Y., 14⅝ cts.; L. P. & J. A. Smith, Cleveland, 18 cts.; R. J. Cram, Sault Ste. Marie, Mich., 24 cts.; Hingston & Woods, Buffalo, N. Y., 15¼ cts.; John Stang, Lorain, 13.9 cts.; Geo. Lockerbie, Detroit, Mich., 18 cts.—The lowest bid for about 320 ft. of pier extension at Conneaut was that of L. P. & J. A. Smith, Cleveland. The pier is to consist of cribs 40 ft. long, 24 ft. wide and 19 courses high, filled with stone. The prices were as follows: Dredging cuts for cribs, 25 cts. per cu. yd.; hemlock timber and plank, $22 per M. ft.; white pine, $32; white oak, $34; stone for filling cribs, $7; iron plates, bolts, etc., 3 to 4 cts. per lb.

MISCELLANEOUS.

COURT HOUSE.—Mountain City, Tenn.—Bids will be received by J. H. Church until June 5 for a new court house. W. Chamberlin & Co., architects, Knoxville.

JAIL.—Danville, Va.—Bids are asked for iron cells for an addition to the city jail. C. A. Ballou, Cy. Engr.

DREDGING.—Baltimore, Md.—Bids are asked until May 18 for dredging about 305,000 cu. yds. N. H. Hutton, Engr. Harbor Board.

BREAKWATER.—Ottawa, Ont.—The department of public works will receive bids until June 9 for the reconstruction of the breakwater at Point du Chene, Westmorland Co., New Brunswick. E. F. E. Roy, Secy.

WATER POWER.—Winnipeg, Man.—The water power committee will receive bids until June 8 for the construction of works necessary to make available the water power of the Assiniboine River in this city. The city desires 400 HP. for its own purposes, and the minimum power at ordinary low water is estimated at 5,000 to 10,000 HP. L. A. Nares, Chn. Com.

GARBAGE DISPOSAL.—Troy, N. Y.—The city council has authorized the contracting board to contract for the cremation of the city garbage for not more than five years.

TURBINE POWER PLANT.—Detroit, Mich.—The only bid received by Gen. O. M. Poe, U. S. Engineer Office, for the entire contract for furnishing the turbine power plant for the new 800-ft. lock at the St. Mary's Falls Canal was that of Hughes Bros. & Bangs, Syracuse, N. Y., at $37,601. The Dayton Globe Iron Works, Dayton, O., bid $5,663 for the turbine wheel and fittings.

ROCK EXCAVATION.—Chicago, Ill.—The contract for the removal of 70,000 cu. yds. of limestone rock in the bed of the Kankakee River near Momence, Ill., noted in our issue of April 6, has been sublet by Chas. T. Mason to the J. D. Moran Mfg. & Const. Co., St. Paul, Minn. This improvement is being carried on under the supervision of the State of Indiana, the legislature having appropriated $65,000 for the work. It is expected that the removal of this rock will make many thousands of acres of marsh lands situated in the northwest part of the state suitable for agriculture.

INDUSTRIAL NOTES.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have an order for 4 mogul engines, 2 consolidation engines, 1 eight-wheel engine and 1 six-wheel switching engine for the Cincinnati, New Orleans & Texas Pacific, and also for 10 Vauclain four-cylinder compound engines for the Missouri, Kansas & Texas.

The Schenectady Locomotive Works, Schenectady, N. Y., have orders for 10 consolidation engines for the Boston & Albany, and 15 ten-wheel, two-cylinder compound engines for the Minneapolis, St. Paul & Sault Ste. Marie.

The Rogers Locomotive Works, Paterson, N. J., have an order for 33 engines for the Illinois Central, and another order for 8 six-wheel tank engines for the Chilean government.

The Brooks Locomotive Works, Dunkirk, N. Y., have an order for 15 engines for the Illinois Central.

The Dickson Mfg. Co., Scranton, Pa., has built 3 mogul passenger engines for the New York, Ontario & Western.

CARS.—The St. Charles Car Co., St. Charles, Mo., has built three buffet cars for the Wabash; they are 68 ft. long, on six-wheel trucks.

The Ohio Falls Car Mfg. Co., Jeffersonville, Ind., has an order for 20 passenger cars for the New York, Ontario & Western.

The Duluth Mfg. Co., Duluth, Minn., is building a number of Thacher pneumatic dump cars; including 50 for the Duluth & Iron Range.

The Columbian Car Works Co. has been organized at Cincinnati, O., with a capital stock of $250,000.

DREDGE.—M. Beatty & Sons, Welland, Ont., have built a large dredge for the Welland Dredging Co.; 107 ft. long, 35 ft. beam, 3,000 cu. yds. daily capacity; cost, $30,000.

THE TOLEDO BRIDGE CO., Toledo, O., is erecting a new building, 250×90 ft., for the manufacture of structural ironwork.

THE BROWNE & SHARPE MFG. CO., Providence, R. I., reports that the principal additions this year to the machines and tools which it regularly manufactures are Nos. 2 and 3 universal milling machines, Nos. 2 and 3 plain milling machines, No. 1 automatic screw machine, circular milling attachment; flanged rises, new sizes of milling machine cutter arbors, new index plates for milling machines, new sets of tools for milling machines, new sizes of milling cutters and side milling cutters, standard T-slot cutters, new sizes of special bevel and miter gear patterns, micrometer calipers and gear tooth caliper. Owing to the increase of the number of the milling machines regularly manufactured the company has in its new catalogue renumbered all of these machines.

NEW COMPANIES.—Griffin Car Wheel Co., Chicago, Ill.; $1,250,000; Thomas A. Griffin, G. G. Willard and W. W. Evans. N. P. Glann Construction Co., Galesburg, Ill.; $10,000; N. P. Glann, John Lagenderfer and R. E. Melville. Newbern Brick Co., Newbern, Ill.; $150,000; Wm. Courtney, G. H. Smiley and Levi Davis. State Iron Works, Galveston, Tex.; $50,000; J. A. Stall, A. Crane and Wm. Stephenson.

NOTICE TO SEWER CONTRACTORS.

Ishpeming, Mich., May 6, 1893.

The Sewer Committee of the Common Council of the City of Ishpeming, Michigan, will receive proposals until 12 o'clock noon of Wednesday, May 31st, 1893, for building districts numbered 1 and 5 of the Ishpeming Sewer System.

Contractors may bid upon one or both districts; the proposal for each district must be enclosed in a separate envelope, sealed and properly endorsed.

Each proposal must be on a blank form furnished by the City, and be accompanied by a certified check, drawn and made payable to the order of the Treasurer of the City of Ishpeming, for the sum of five hundred dollars ($500); this check (or checks) to be forfeited by the successful bidder should he refuse to enter into a contract to do the work so awarded within five (5) days after receiving official notice of the award. Checks will be returned to unsuccessful bidders after the contracts are signed.

The engineer's estimate of the amount of work for each district, which will be used in comparing the proposals, is as follows:

Kind.	Dist. No. 1	Dis. No. 5.
30 inch brick sewer..	780 lin. ft.	
24 inch brick sewer. ..	540 lin. ft	950 lin. ft.
18 inch pipe sewer...	135 lin. ft.	350 lin. ft.
15 inch pipe sewer...	1500 lin. ft.	1330 lin. ft.
12 inch pipe sewer...	2882 lin. ft.	1730 lin. ft.
10 inch pipe sewer...	844 lin. ft.	535 lin. ft.
8 inch pipe sewer...	3305 lin. ft.	1715 lin. ft.
Flush tanks.....	14	6
Man holes.....	20	24
Lamp holes.....	11	10
Catch basins.....	60	55

Cast iron covers, ladder irons, curb boxes and flushing siphons will be furnished by the City.

The successful bidder will be required to furnish satisfactory bonds insuring the proper fulfillment of the conditions of his contract.

Plans can be examined and specifications, forms of proposal, contract and bonds obtained at the office of the Engineer in Charge, City Hall, in said City.

The committee reserves the right to reject any or all bids.

W. H. JOHNSTON,
HENRY ROUTHIER,
AUG. SWANSON,
Sewer Committee.
MELVILLE S. HAWKINS,
Engineer in Charge. 19-3t

PROPOSALS FOR SEWERS.

Sealed proposals will be received by the Commissioners of Sewers and Drainage of the Village of New Rochelle, Westchester Co., N. Y., until 6 o'clock p. m., May 22, 1893, for the construction of Sections No. 4 and No. 5 of the sewer system of said village in accordance with plans and specifications on file at the office of said Commissioners. Proposals for each section to be made separately.

Each proposal must be accompanied by a bond in the penal sum of one thousand dollars ($1,000), with two sureties, conditioned that same shall be forfeited to the Commissioners if the person or persons to whom the contract may be awarded shall neglect or refuse to execute the same within ten days after notification by the Commissioners that his or their proposal had been accepted.

The contractor will be required to furnish a bond with two or more sureties approved by the Commissioners in the penal sum of ten thousand dollars ($10,000), for section No. 4, and eight thousand dollars ($8,000) for section No. 5, conditioned and as security for the faithful performance of the contract and as indemnity for damages as provided by Section 8, Chapter 201, Laws of 1889.

The Commissioner of Sewers and Drainage reserve the right to reject any or all proposals and to award the contract to other than the lowest bidder or to re-advertise for proposals if they shall deem such course advantageous to the interests of the Village of New Rochelle.

Plans, specifications, form of proposal and further information can be obtained from J. K. Wilkes, C. E., at the office of the Commissioners, 284 Main street, New Rochelle, N. Y.

By order of the Commissioners.

JAMES W. TODD, Secretary.

Dated, New Rochelle, N. Y., May 1, 1893. 19-2t

SEWER PIPE AND CEMENT.—Proposals will be received until May 18th, 1893, for furnishing 34,000 feet of vitrified sewer pipe and 2,900 barrels of cement. For specifications and further information address G. A. WETHERBEE, City Engineer, Malden, Mass.

UTICA PIPE FOUNDRY CO.

CAST IRON PIPE AND SPECIALS FOR WATER AND GAS.

Also flanged Pipe and Fittings, Hydrants, Gates, Pig Lead, etc. CHAS. MILLAR & SON, Selling Agents, Utica, N. Y. Manufacturers of Lead Pipe and Plumbers' Materials. Wholesale Eastern Agents Akron Vitrified Sewer Pipe.

JOHN W. HARRISON, Pres. and Treas. THOS. HOWARD, Vice Pres.
F. B. NICHOLS, 2d Vice-Pres. E. H. QUEEN, Sec'y. P. MCARTHUR, Supt.

HOWARD-HARRISON IRON COMPANY,
MANUFACTURERS OF

CAST IRON PIPE

FOR WATER-WORKS, GAS WORKS, CULVERTS.
Pipe and Pump Connections. Flexible Joints. Heavy Loam Castings.
Works at BESSEMER, ALA. Offices at BESSEMER and ST. LOUIS.

ARTHUR KIRK & SON, PITTSBURGH, PA.

POWDER, DYNAMITE, ROCK DRILLS,
AIR COMPRESSORS, ROCK BREAKERS,
Safety Fuse, Electric Batteries, Miners' Squibs.

FOR Best Results USE THE WARREN FILTER,
—MANUFACTURED BY—
CUMBERLAND MFG. CO., Boston, Mass.

THE STANDARD CONSTRUCTION CO.,
GENERAL CONTRACTORS.
SEWER AND MASONRY BUILDING, STREET PAVING, ETC.
Main Office, Lewis Block, Pittsburg, Pa.

The Only Practical Solution of the high service difficulty is the

Lang High Service Motor

Now in successful operation at New London, Conn., and Burlington, Vt. See ENGINEERING NEWS, issue of Jan. 19, 1893, for details. Absolute economy, highest possible efficiency. Guaranteed. Correspondence solicited.

LANG & GOODHUE MFG. CO., Hydraulic Engineers,
BURLINGTON, VT.

Smoothness of motion, absolute safety and high speed are among the good qualities possessed by

OTIS ELEVATORS.

They are built by Otis Brothers & Co., 38 Park Row, New York.

PROPOSALS FOR SEWER PIPE—CITY OF HOLYOKE.

Holyoke, Mass., May 4th, 1893.

Sealed proposals will be received by the undersigned until May 16th, 1893, 5 p. m., to furnish the City of Holyoke with 15,000 lineal feet of perfect vitrified drain and sewer pipe, with the privilege of ordering 50,000 lineal feet at prices specified in bids, sizes of pipes ranging from 12 inches diameter to 20 inches diameter.

Pipe must be delivered f. o. b. cars Holyoke, and to be sent at shipper's risk.

The right is reserved to reject any or all bids.

Bids must be addressed to Rufus B. Holmes, Chairman Committee on Sewers and Drains, Holyoke, Mass.

RUFUS B. HOLMES.
Chairman Com. Sewers and Drains. 19-1t

PROPOSALS FOR WATER-WORKS.

Sealed proposals will be received at the office of the Water Commissioners of the City of Bradford, Pa., until 12 o'clock, noon, of the fifth (5) day of June, 1893, for furnishing the City of Bradford with the material, and for performing the labor necessary to the construction of a reservoir to hold 60 million gallons, and also the furnishing and laying of about seven miles of cast iron pipe, for an additional water supply for the City of Bradford, to be built in accordance with plans and specifications on file in the office of the Water Commissioners.

Separate bids will be required for the different divisions of the work.

For blank forms, specifications, or any other information, address the Superintendent of the Water Department or the City Engineer.

The City reserves the right to reject any or all bids.

S. D. HEFFNER,
Supt. Water Department.
F. W. DALRYMPLE,
City Engineer.
T. B. CLARK,
F. D. WOOD,
W. C. KENNEDY,
Water Commissioners.
19-3t

UNITED STATES ENGINEER OFFICE, Wilmington, Del., April 18th, 1893.—Sealed proposals for dredging and excavating for the construction of an inland waterway from Chincoteague Bay, Va., to Delaware Bay, Del., will be received at this office until 12 o'clock noon, May 18th, 1893, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. WM. F. SMITH, United States Agent. 16-3t

COMMONWEALTH OF MASSACHUSETTS METROPOLITAN SEWERAGE COMMISSIONERS—NOTICE TO BUILDERS OF PUMPING ENGINES.—Sealed bids for the pumping plant for the Metropolitan Sewerage pumping station at East Boston, and sealed bids for the pumping plant for the Metropolitan sewerage station at Deer Island, will be received by the Board of Metropolitan Sewerage Commissioners at its office, 110 Boylston Street, Boston, Mass., until 12 o'clock m. of Saturday, May 27, 1893, and at that time will be publicly opened and read.

The Board will provide at each pumping station an engine house, boiler house, chimney and masonry foundations for the pumps, and will furnish a fresh-water supply for the boilers up to the interior of the boiler house. The contractor's bid for each plant must be for furnishing, setting up, and completing, ready for use, two pumping engines (or sets of engines), four boilers, piping and all necessary appliances and fittings such as are to be found in pumping stations of the best class.

Each pumping engine must be capable of easily raising 70 cubic feet of sewage per second 19 feet vertically above the level of the sewage in its respective pump-well. Each of the engines must also be capable of raising to greater lifts up to 25 ft. quantities of sewage inversely proportional to such lifts.

Each engine must also be capable of pumping at as low a rate as 15 cubic feet per second, and at all rates between 15 and 70 cubic feet per second.

The foregoing capacities must be demonstrated by suitable trials.

Each bidder must state in his bid the duty he will guarantee for each engine in the duty trials outlined in the general specifications:

Table of Some Approximate Working and Trial Data, Etc.

	Deer Island.	East Boston.
Elevation of the surface of the sewage in the pump-well above datum....(Varies from	Feet. 94.0	Feet. 99.8
(to	101.4	93.5
Elevation of the bottom of the pump well is assumed to be..	85.5	80.0
Elevation of the surface of the sewage in the discharge channel above datum.(Varies from	101.0	105.3
(to	120.0	112.5
Least lift.....	6.0	14.5*
Average lift.....	11.0	15.0
Ordinary maximum lift.....	18.6	19.0
Lift during duty trial at rate of 70 cu. ft. per sec.....	11.0	15.0
Lift during capacity trial at rate of 70 cu. ft. per sec...	19.0	19.0
The elevation of the boiler house floor should be not lower than.....	116.5	116.5

The elevations mentioned above are referred to a datum about 100.04 feet below mean low water of Boston Harbor.

The contractors must provide at each station four steam boilers of such capacity that any three of them can easily supply the necessary steam for the two engines when discharging together 140 cubic feet per second with a lift of 19 feet.

Plans will be furnished by the Board showing the position of the engine houses and the in-coming and out-going sewers at East Boston and Deer Island.

The first pumping engine at each station, and at least two boilers at each station, must be set up, ready to run, before May 31, 1894; the remaining engine, boilers and other appliances before Aug. 31, 1894. A third pumping engine and additional boilers will probably be called for at each station within a few months thereafter, and a fourth engine and additional boilers may be needed in the future. The third and fourth engines and their boilers are not now to be bid for. The arrangement of the plant, however, must be such as will not interfere with the above named extension.

The design of the pumping engines may be of any form which will fulfill the required conditions of the general specifications.

Each bid must be accompanied by drawings showing clearly the size and arrangement of the steam cylinders, pumps, boilers and all other parts of the mechanism and must also show the necessary details for the engine foundations, which are to be provided by the Board.

The specifications, which must also accompany the bid, must give the kind and the quality of the materials of which the various parts are to be composed, the size and the strength of the principal working parts, and the manner in which they are to be constructed, so as to furnish a clear understanding of all points regarding the workmanship, strength, durability, general efficiency of and space occupied by the whole mechanism and plant.

Each bid must be inclosed in a sealed envelope indorsed "Proposal for Pumping Plant for the Metropolitan Sewerage Pumping Station at East Boston" or "Proposal for the Pumping Plant for the Metropolitan Sewerage Pumping Station at Deer Island," and be delivered to the Board or to its clerk.

Each bid must be made on one of the blank forms furnished by the Board, and must be accompanied by a properly certified check for the sum of $1,000, the latter to be returned unless forfeited by the abandoning of the proposal.

The Board reserves the right to reject any and all bids.

Plans, blank forms, general specifications and further information may be obtained at this office.

HOSEA KINGMAN,
TILLY HAYNES,
HARVEY N. COLLISON,
Board of Metropolitan Sewerage Commissioners of Massachusetts.
HOWARD A. CARSON,
Chief Engineer. 18-4t

TO SEWER CONTRACTORS.

The Board of Public Works and Affairs of Nashville, Tenn., will be prepared to receive bids until 3 o'clock p. m., Tuesday, May 16th, 1893, for constructing sections A, B, C, D and E of the Lick Branch Sewer, and all necessary connections and incidental work.

Contractors may bid on any or all sections; but if more than one section is bid on, the bids must be separate.

The said Board reserves the right to reject any or all bids, and to award the contract as a whole, or in such portions as the interest of the city requires or to award any contract for any section, and to reject all other bids.

All bids must be accompanied by a certified check, payable to the order of the Board of Public Works and Affairs, in the sum of $1,000 for each section of said work bid upon. This check (or checks) to be forfeited by any bidder to whom any bid is awarded and who shall thereafter refuse to enter into a contract to do the work so awarded.

Specifications and drawings can be examined at the City Engineer's office.

Bidders are informed that, according to the act of the Legislature of 1893, no bidder shall employ convict labor in the said work or any part of it.

By order of the Board of Public Works and Affairs. J. A. JOWETT,
16-4t City Engineer.

PROPOSALS FOR FREE BRIDGE.

Notice is hereby given that the undersigned will, on June 5, 1893, at the office of the County Judge of Pulaski County, receive plans and working specifications for building a bridge across the Arkansas River at Broadway Street, in the city of Little Rock, reserving the right to reject any and all plans and specifications. No plans and specifications will be paid for unless finally accepted.

This 27th day of April, 1893.

W. A. COMPTON,
County Judge.
GEO. L. BASHAM,
W. B. WORTHEN,
18-3t Commissioners.

NOTICE TO SEWER CONTRACTORS

Sealed proposals will be received for the construction of approximately six miles of sewers, ranging from 8-inch sewers to 44 × 66-inch double-ring brick sewers, with appurtenances, until May 16th, 1893, at 6 o'clock, p. m., at the office of the City Clerk of the City of Marinette, Wis.

Plans, profiles, specifications, and blank form of proposal may be found for examination at the office of the City Clerk.

The Common Council reserves the right to reject any or all bids.

J. K. SETRIGHT,
E. L. SHAW, City Clerk.
City Engineer. 18-2t

TO WATER-WORKS CONTRACTORS.

Sealed proposals are invited until 2 o'clock p. m., May 25th, 1893, for laying and setting pipe and appurtenances; also for erecting stand-pipe, engine-house and steam pumping plant complete, for Cambridge Md., Water-Works. Certified check required with all proposals and penalty imposed for failure to complete contract on time. Right is reserved to reject any or all bids. Plans and specifications may be seen as follows:

THE CAMBRIDGE WATER CO.,
Cambridge, Md.
ISAAC S. CASSIN & SON, Engineers,
1404 N. 12 St., Philadelphia, Pa.
18-3t

WATER-WORKS AT FREDERICK, MD.

Sealed proposals will be received until Thursday, June 1, 1893, by the Water Committee of Frederick, Md., for the construction of a reservoir, with a capacity of 6,000,000 gallons of water. Plans, specification and contracts will be on exhibition at the office of the City Registrar, City Hall, Frederick, Md. Blank form of plans, specification and contracts will be furnished on application. Each bid must be accompanied by a certified check to the amount of $200 as a guarantee of good faith. The right to reject any and all bids reserved.

JOS. F. EISENHAUER,
Chairman Water Committee.
Frederick, Md. 18-4t

STREET PAVING—NOTICE TO CONTRACTORS.

Sealed proposals will be received by the City Clerk of Lima, Ohio, by R. H. Gamble, Assistant Engineer in charge of street paving, until 12 o'clock noon (central standard time) of Thursday, May 25th, 1893, and opened immediately thereafter, for the paving of the Public Square, in the city of Lima, Ohio, with vitrified paving brick, together with all curbing, catch basins, drainage, etc., incident thereto, in accordance with plans and specifications on file in the office of the Engineer. All bids which are not made on forms furnished by the Engineer, or which are submitted on any other conditions than those stipulated in said form or specifications, will be rejected as irregular and informal. No bid will be considered unless accompanied by a certified check (payable to the City Clerk), or legal currency to the amount of five hundred (500) dollars, or by the City Clerk's receipt for the same. All such deposits will be returned to the unsuccessful bidders within ten (10) days from the award of contract. If the successful bidder shall refuse or neglect to execute a proper contract and furnish a bond acceptable to the City Council within ten (10) days from the time said contract shall have been awarded to him, the said certified check or currency shall be forfeited to and retained by the said city of Lima, Ohio, as liquidated damages for such refusal or neglect, otherwise the said deposit will be returned to him.

Samples of brick and stone and samples or models of iron sewer inlets must be submitted with bid.

The following are the approximate quantities of work:

12,635 square yards of brick pavement.
1,400 lineal feet of six (6) inch curbing.
8 circular curb corners.
6 catch basins.
12 iron gutter crossings.

Together with the necessary sub-drainage, etc.

The City reserves the right to reject any or all bids, before or after opening the same, which may be accompanied by samples of brick which in the opinion of the Engineer will not meet the requirements of the specifications; and to accept any proposal which may be deemed most proper.

Specifications, forms of proposal and other information may be had on application to R. H. Gamble, Assistant Engineer, Lima, Ohio.

By order of Council.
Lima, Ohio, April 25, 1893.

D. E. JONES,
President of Council.
J. B. DOUGLASS, City Clerk. 18-3t.

PROPOSALS FOR WATER-WORKS.

The Borough of Pine Grove, Pa., will receive sealed proposals, addressed to the Chief Burgess, on and up to 8 p. m., May 23d, for the construction of their water-works, consisting of about 4¾ miles of pipe from 10 to 4 inches in diameter, with special castings, valves, valve boxes, 24 fire hydrants, etc. Earthen dam about 140 feet long and 18 feet high. Proposals will be received for the above work in whole or in part.

Each proposal for pipe-laying or building dam must be accompanied by a certified check, payable to the order of the Chief Burgess, as follows:

For pipe-laying..... $200.00
For building dam..... $150.00

as a guarantee that in case the contract is awarded the parties to whom such award is made will execute the contract with satisfactory security within five days after notification.

The Borough reserves the right to reject any or all proposals.

Specifications and plans can be seen and obtained of the Borough Clerk or their Engineer.

THOMAS B. HUGHES,
Chief Burgess.
AARON T. FELTY,
Borough Clerk.
FRED C. DUNLAP, Engineer.
No. 865 N. 20th St., Phila., Pa.
17-3t

OFFICE OF LIGHTHOUSE ENGINEER, Fifth District, Baltimore, Md., April 7, 1893.—Sealed proposals will be received at this office until 2 o'clock p. m. of Wednesday, the 17th day of May, 1893, for furnishing the materials and labor of all kinds necessary for the completion, delivery and erection at the sites of the metal work of Cape Charles and Hog Island Light Towers, Virginia, for a fixed sum for each light tower, or for an aggregate sum for both towers. The bids most advantageous to the United States Government will be accepted. Plans, specifications, forms of proposal and other information may be obtained on application to this office. The right is reserved to reject any or all bids and to waive any defects. ERIC BERGLAND, Captain of Engineers U. S. A., Lighthouse Engineer, Fifth District.
15-5t

U. S. ENGINEER OFFICE, NEWPORT, R. I., April 14, 1893.—Sealed proposals, in triplicate, will be received at this office until 11 a. m., May 23d, 1893, and then opened, for furnishing and delivering 900 barrels of American hydraulic cement; of which 500 barrels are to be delivered at Fort Adams, Newport Harbor, R. I., and 400 barrels at Dutch Island, Narragansett Bay, R. I. For all information apply to W. H. BIXBY, Captain, Corps of Engineers, U. S. Army. 17-4t

NOTICE TO CONTRACTORS FOR STREET WORK.

Notice is hereby given that sealed bids will be received until Monday, the 15th day of May, 1893, at 6 o'clock, p. m., by the Burgesses and inhabitants of the borough of Greensburg, in the county of Westmoreland, for the grading, curbing and paving of North Main street, between the southern line of intersection of property of Jane and Isabella Armstrong and Delmont street; also for the grading, curving and paving of North Maple avenue, between Park and Best streets, according to plans and specifications now on file with E. H. Bair, Chairman of the Street Committee. Each person bidding will be required to put in, with his bid, a certified check in the sum of $200, payable to Treasurer of said borough, the check of the person receiving the contract to be forfeited, unless he signs a contract, in accordance with his bid, within five days after written notice that the same has been awarded to him; otherwise his bid will not be considered, and the Burgesses and inhabitants of the borough of Greensburg reserve the right to reject any and all bids.

All bids must be filed with E. H. Bair, Chairman of the Street Committee, at the office of Gay, Bair & Lane, where a copy of the plans and specifications may be seen.

J. COVODE REED,
19-1t Chief Burgess.

NOTICE TO BRIDGE CONTRACTORS.

Sealed proposals, addressed to the Auditor of St. Joseph County, South Bend, Indiana, will be received by the Board of Commissioners of said county, until 12 o'clock, noon, Monday, June 5th, 1893, for the furnishing all material, the construction and erection of a through wrought iron bridge, to be completed by November 10th, 1893, consisting of a single span 150 ft. in the clear, between abutments—no sidewalks—18 foot roadway, across the Baugo Creek, near Osceola, this county. The distance from grade to bed of stream is about 15 feet. The center line of bridge will be at right angles to face of abutments. The bridge must be of first-class material, proportioned—Theodore Cooper's Specifications being used—to carry 70 pounds per square foot of floor surface on trusses for live load, and 100 pounds live load per square foot on flooring system. Bidders to furnish a clearly made out strain sheet of their design, with data on which it was computed, and showing also areas of material proposed to be given to each part, together with forms of cross-section of upper chords and posts, and compression members generally.

At the same time and place, separate bids will be received until the hour above named for the furnishing of all material and the construction of two stone abutments for said bridge, plans and specifications of which may be seen on file in said auditor's office. The masonry to be completed by September 15th, 1893. The Commissioners reserve the right to reject any or all bids for either or both abutments and superstructure. ROBERT MYLER,
19-1t Auditor of St. Joseph County.

World's Fair Route.

The Cincinnati, Hamilton & Dayton R. R. is the only line running Pullman's Perfected Safety Vestibuled Trains, with Chair, Parlor, Sleeping and Dining Car Service, between Cincinnati, Indianapolis and Chicago, and is the Only Line running Through Reclining Chair Cars between Cincinnati, Keokuk and Springfield, Ill. It is the popular line between Cincinnati and St. Louis with Through Sleeping Cars on Night Trains and Chair Cars on Day Trains, and the Only Direct Line between Cincinnati, Dayton, Lima, Toledo, Detroit, the Lake Regions and Canada.

Tickets on sale everywhere, and see that they read C., H. & D., either in or out of Cincinnati, Indianapolis, or Toledo. E. O. McCORMICK, General Passenger and Ticket Agent, Cincinnati, O. 51-20t-eow

U. S. ENGINEER OFFICE, CHARLESTON, S. C., April 15, 1893.—Notice is hereby given to all parties interested in the wreck of the schooner "Kate V. Aitken," in Swash Channel, Charleston Harbor, S. C., or in the cargo, if any, of said craft, that if same are not removed within 30 days it is the purpose of the Hon. the Secretary of War of the United States to treat said wreck and cargo as abandoned and derelict, and cause their removal, as prescribed by Sec. 4, Act of Congress, approved June 14, 1880. Sealed proposals for removing this wreck will be received at this office until 12 noon of May 15, 1893, and then publicly opened. Specifications, blank forms and all available information will be furnished on application to this office. 16-4t

COMMONWEALTH OF MASSACHUSETTS.

METROPOLITAN SEWERAGE COMMISSIONERS.—NOTICE TO BUILDERS OF PUMPING ENGINES.

Sealed bids for the pumping plant for the pumping station at CHARLESTOWN will be received by the Board of Metropolitan Sewerage Commissioners at its office, 110 Boyleston Street, Boston, Mass., until 12 o'clock m. of Saturday, July 1, 1893, and at that time will be publicly opened and read.

The Board will provide an engine-house, boiler-house, chimney and masonry foundations for the pumps, and will furnish a fresh water supply for the boilers up to the interior of the boiler-house. The contractor's bid must be for furnishing, setting up and completing, ready for use, two pumping engine (or sets of engines), two boilers, piping, and all necessary appliances and fittings, such as are to be found in pumping stations of the best class.

Each pumping engine must be capable of easily raising 35 cubic feet of sewage per second 11 feet vertically above the level of the sewage in its respective pump well. Each of the engines must also be capable of raising to greater lifts up to 30 feet, quantities of sewage inversely proportional to such lifts.

The contractors must provide at each station two steam boilers of such capacity that either of them can easily supply the necessary steam for the two engines when discharging together 70 cubic feet per second, with a lift of 11 feet.

The design of the pumping engines may be of any form which will fulfill the conditions named in the general specifications.

Each bid must be made on one of the blank forms furnished by the Board, and must be accompanied by a properly certified check for the sum of $1,000, the latter to be returned unless forfeited by abandonment of the proposal.

The Board reserves the right to reject any and all bids.

Plans, blank forms, general specifications and further information may be obtained at this office.

HOSEA KINGMAN,
TILLY HAYNES,
HARVEY N. COLLISON,
Board of Metropolitan Sewerage Commissioners of Massachusetts.
HOWARD A. CARSON,
19-8t Chief Engineer.

PROPOSALS FOR WATER-WORKS, HILLSBORO, OHIO.

Proposals will be received by the Village of Hillsboro, Ohio, up to 12 o'clock, noon, of the 14th of June, 1893, for a complete system of water-works, approximately as follows:

1st Division.—A system of not less than twelve 8-inch wells, approximately 50 feet deep, properly connected.

2d Division.—Brick building, with stone foundation, for pumping station.

3d Division.—Two compound, duplex pumps of a capacity each of 1,000,000 gallons per twenty-four hours, with boilers and all appurtenances.

4th Division.—One stand-pipe, 15 feet in diameter, 160 feet high; also foundation for same.

5th Division.—Pipe distribution system, consisting of approximately 9.05 miles of pipe, varying from 10 inches to 4 inches in diameter, with valves, special casting and 68 fire hydrants.

Bids will be received upon the whole or any division of the work.

Each bid must be made upon a blank form furnished for the purpose, and must be accompanied by cash, draft or certified check for an amount equal to $100, plus 1½ per cent. of the amount of the bid, and made payable to the order of the Village Clerk.

Bids to be addressed to the Village Clerk of Hillsboro, Ohio, and marked, "Proposal for Water-Works."

Plans, specifications and form of proposal are on file at the office of the Consulting Engineer, and also in Hillsboro, Ohio, at the office of the Village Clerk, to whom all communications should be addressed.

The right to reject any or all bids is specially reserved.

N. H. AYRES,
H. D. DAVIS, Village Clerk.
Mayor.
EDWARD FLAD, Consulting Engineer.
118 Laclede Building, St. Louis, Mo. 19-3t

TO ENGINE AND BOILER MAKERS.—Office of Engineer, Tenth District, 185 Euclid Avenue, Cleveland, Ohio, May 1, 1893.—Sealed proposals will be received at this office until 2 o'clock, p. m., of Wednesday, May 17, 1893, for furnishing the boilers, machinery, etc., for three steam fog signals delivered and erected, one at each of the following-named light stations: Genesee, N. Y., Buffalo Breakwater, N. Y., and Ashtabula, Ohio. Specifications, forms of proposal, and other information may be obtained on application to the undersigned. The right is reserved to reject any or all bids, and to waive any defects. JARED A. SMITH, Lieut.-Col. Corps of Engineers, U. S. A., Engineer Tenth Lighthouse District. 19-1t

For other Proposals see page XXI.